CHEMICAL & METALLURGICAL ENGINEERING

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APRIL 1939

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What's ahead

More About May

Last month we recounted very briefly what was planned for the Process Equipment Design Section which is to be the feature of the May issue. A few of the things our authors will tell you about include: how to design for most effective operation; what non-process factors affect design; what codes must be considered in design; how to go about the choice of materials of construction; how to use expensive alloys economically; what the minimum mathematics of design is; how to design equipment supports and foundations; how to house equipment economically; the fundamentals of design involved in a variety of classes of process equipment; and how to build inherent safety into your equipment.

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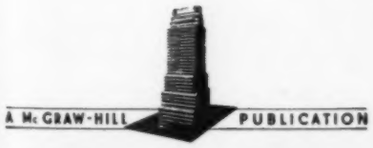
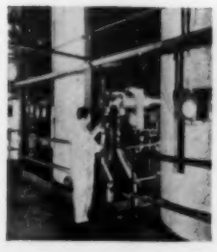
E. S. STATELER, 520 N. Michigan Ave., Chicago, Ill.





Cover picture showing purification of phenol in a battery of stills in the plant of the Dow Chemical Co. Other illustrations appear in the pictured flow sheets on pages 221–224 of this issue. [*This cover resigned for editorial use by the Pfaudler Co.*]

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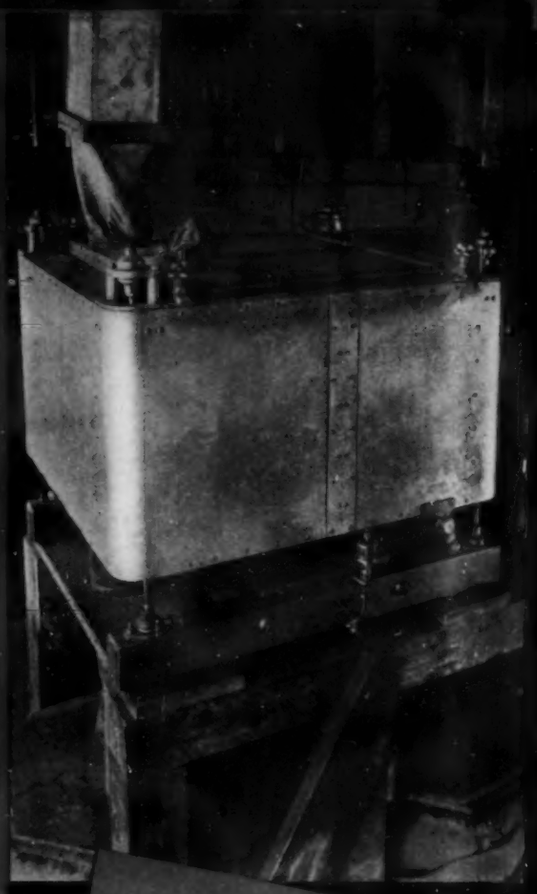
How the Superior Flake Graphite Company got

PRODUCT CONTROL



THE SUPERIOR FLAKE GRAPHITE COMPANY and its products hold an important place in modern industry. Graphite keeps wheels turning smoothly . . . makes fast boats slip through the water with even greater speed . . . provides an electrical conductor in the making of electrotypes . . . prevents losses by friction in countless instances. If graphite is to do its work efficiently, its quality must be maintained to rigid standards. That's why the Superior Flake Graphite Co. chose an Allis-Chalmers Low-Head Gyratory Sifter for their Chicago plant.

Here's How Allis-Chalmers BEAT GRANULATION WASTE For a Graphite Processor! Learn How Allis-Chalmers, with 90 Years of Engineering Experience, Can Get Uniform Granulation... Cut Costs For YOU!

ANOTHER CASE HISTORY FROM THE ALLIS-CHALMERS FILES!

You men in the process industries — like everybody else — are in business for only one reason. You want to make money! And you can't make money unless you keep your costs down . . . unless you get the greatest yield for your money . . . unless you **beat granulation waste!**

That's what the Superior Flake Graphite Co. wanted! They needed to get a cleaner separation of their product to meet exacting consumer specifications. They had to find a method of getting product control!

Waste Granulation . . . "Dusting Out"

It wasn't an easy job! For graphite — hard to handle, slippery, flour-fine — seeps through any outlet . . . through the slightest opening or airstream in an ordinary sifter. And granulation too coarse or fine is equally wasted!

They brought their problem of product control to Allis-Chalmers. And, after a series of tests in the laboratory, Allis-Chalmers engineers recommended the replacement of the machine in their plant with a Low-Head Gyratory Sifter.

They Got What They Wanted!

The Superior Flake Graphite Co. got what they wanted! They got a machine that was more compact, more accessible than their former sifter . . . easier to install . . . more economical to run. And the Low-Head Gyratory Sifter actually reduced "dusting out" to an absolute minimum!

But — more important — they beat granulation waste! They got a cleaner separation . . . a more saleable product. They met specifications more accurately. They were even able to recover a large stock of graphite . . . rejected as too coarse . . . by rebolting it to the proper granulation in their new machine!

This is an unusual case — but not an exaggerated one. For Allis-Chalmers grinding and sifting equipment is saving thousands of dollars every year in plants throughout the process industries. Applications and methods to get uniform granulation for special materials are constantly being derived by technical knowledge of Allis-Chalmers engineers.

Let Allis-Chalmers Work For You!

Find out what Allis-Chalmers can do for you. In the district office near you is a trained engineer, who'll be glad to tell you how 90 years of engineering experience can be put to work in your plant to get you more yield for your money . . . to beat granulation waste!

960

FLOUR MILL DIVISION

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NORDYKE DOUBLE ROLLER MILLS • NORDYKE SQUARE SIFTERS • LOW-HEAD GYRATORY SIFTERS • VERTICAL GRINDERS • ALLIS and NORDYKE REELS • AND SPECIAL APPLICATIONS FOR THE PROCESS INDUSTRIES

CHEMICAL & METALLURGICAL ENGINEERING
ESTABLISHED 1902

APRIL, 1939

S. D. KIRKPATRICK, *Editor*

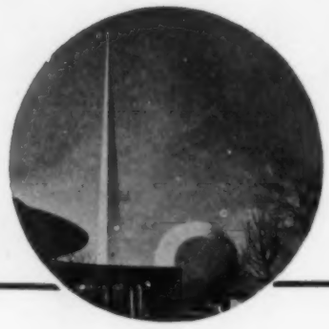
Fair Play for Both

EVEN THOUGH the "appeasement" program in Washington may not bring prompt reduction in taxes or any other financial incentives for business recovery, it has already served a very useful purpose. At last there is a realization that industry can no longer be the scapegoat for reckless reform and regulation. Public opinion has been aroused. Most people agree that something must be done to lift some of the heavy burdens that have been placed on the back of business —that have slowed up our national progress. One of the worst of these is the Wagner Act with its one-sided and prejudiced operation against the best interests of both employees and employers.

That law came in 1935 at a time when industry was harassed by a dozen other troubles. Management was entirely unprepared for a flank attack that cut off the support of its own employees. As the law was interpreted through the decisions of the National Labor Relations Board, management could not legally present its case to the men in the plant nor warn them of the probable consequences of short-sighted policies being forced on them from the outside. Instead of preventing or diminishing the causes of labor disputes, the number of strikes in industry more than doubled in a year —reaching 4,740 in 1937 as compared with 1,856 in 1934. Even in 1938, with business as bad as it was, there were more strikes than in any year between 1921 and 1933. The first encouraging reversal of this disturbing trend came on February 27, 1939, when the Supreme Court declared that the Fansteel sit-down strike "was a high-handed proceeding without the shadow of legal rights." But there is still a great deal to be done to correct the situation—both by Congress and by industry itself.

The public is demanding that the National Labor Relations Act be amended to provide fair dealings on the part of employees as well as employers. The rights of collective bargaining must be preserved and protected as much from outside (including governmental) influences as from undue pressure generated within. And some measure of protection should be provided for the employer by prescribing certain minimum standards of business conduct and legal responsibility for the labor organizations with which he is compelled by law to deal.

But assume for the moment that the basic law is promptly and equitably revised. There is still the big problem of recovering the lost support and confidence of the employees in some of our plants. This is a public relations job of the highest order. It is a challenge that should be welcomed, especially by chemical engineers who occupy a strategic place between the management and the men. Some employees are beginning to realize that they have been "sold down the river" by mythical promises of political and labor leaders. They are asking now for intelligent and unbiased answers to questions that vitally concern their present and future welfare. They want facts and figures they can understand and appreciate. It is our responsibility—as never before—to supply them with that information. Every company and every plant in the chemical process industries that has evolved a sound policy of human relations should put that program to work *now*.



From an

MILLIONS FOR CATALYSIS

IN ANNOUNCING the recent symposium on catalysis by the Petroleum Division of the A.C.S. at Baltimore, Cary Wagner of the Pure Oil Co., stated that the industry will spend about $200,000,000 in 1939 on plant improvements. A good portion of this will be spent on materials and labor for the construction of new equipment to take advantage of progress made in catalytic operations. Thus another step is taken in changing petroleum refining into a chemical manufacturing industry. It is becoming more and more evident that the hydrocarbons of petroleum can be made most useful to humanity through the methods of organic synthesis. New motor fuels of higher quality will be obtained in better yield from catalytic processes that will no longer require excessively high temperatures and pressures. So it is certain that the large investment which the industry is making today in new technology and equipment will come back several fold in savings to the public.

FIREWORKS AND EXPLOSIVES

EDITORS ARGUE INTERMINABLY about industrial classifications. "What is chemical industry?" is a favorite topic for an armchair editorial whenever the well is running dry. Executives of a manufacturing industry seldom become seriously concerned with such matters, however, unless the particular classification or definition in question carries with it some penalty or stigma.

For years the governmental departments have grouped "explosives, fireworks, blasting powder and ammunition." No one seems to have objected to this until the other day when three of the leading figures in the explosives industry appeared before a hearing of the Children's Bureau of the U. S. Department of Labor, to protest against a proposed regulation that would ban as "oppressive child labor" the employment of all children between 16 and 18 years "in and about plants where explosives, fireworks, blasting powder and ammunition are manufactured."

Surprised to find such a distinguished delegation at her hearing, Miss Katherine Lenroot, chief of the Bureau, quickly discovered the cause of their presence. "We're really not here to protest against this regulation," they told her, "but we are proud enough of our industry not to want to be classified with fireworks makers."

Decision was reserved and an opportunity given for the filing of briefs. At last report there had been no other "fireworks" in the Labor Department—but one wonders that this sort of thing doesn't happen oftener. Maybe we need more—and better editorials!

COME TO THE FAIR!

WHEN FAIR-TIME COMES, we are all children. We want to see the sights and have a good time. Of course we talk about serious educational themes like the World of Tomorrow or Pan-Pacifica. We build beautiful buildings and splash color and water and lights around with reckless abandon. But in the end it all comes back to youthful curiosity, enthusiasm and vigor—the fun of going places and seeing things that are startlingly different and interesting.

So we are not fooling ourselves (very much at least!) when we tell you elsewhere in this issue of the marvelous scientific and engineering achievement you will see if you will come to our World's Fair here in New York. Nor will we be less realistic later when we try to bring you the plans for the great Western Chemical Congress that will attract so many of our lucky friends to the 'Frisco Fair this summer. We merely want to supply you with a few more excuses—chemical as well as cultural and spiritual! Really, now, can you afford to stay away?

CENSUS OF 1939

PRODUCTION OF CHEMICALS and other products of the chemical process industries this calendar year will be reviewed by the Census of Manufactures beginning with next January. Right now the specialists of the Census Bureau are working on plans for the inquiry which will then be made. That inquiry will be more complete next year than usual in a biennial census because it will really be a part of the series of decennial censuses.

Many of the questions asked of chemical industry have been difficult to answer. Sometimes the reports given from the census have not been as satisfying as industry has liked. Those who feel so dis-

Editorial Viewpoint

posed are right now invited to send their suggestions for improvement. Such suggestions will assist in making a better form on which replies can be submitted. They will, if possible, be followed to make the census more complete. They may even influence the form in which the Census reports are finally published.

Those having such suggestions may write directly to the Bureau of the Census in Washington, or they may prefer to work through their own trade associations. The important thing is that industry should cooperate at this early date so that the sincere, hard working specialists of the Census Bureau may have their work count for the most in simple forms and constructive reports for use next year.

IN THE NAME OF "JUSTICE"

SOME MORNING any reader of *Chem. & Met.* may have a caller from the Department of Justice. Quite a number of process industry folks have had such visitors lately, notably the fertilizer industry. These callers will be young attorneys and other investigators who will say that they have come to examine all the files of the company, "or else." If pressed they will admit that the "or else" will be a subpoena. And those who have seen the subpoenas say that they will describe about everything that the company may conceivably have in its records.

All this would be very funny if it did not so strikingly resemble the despotic methods of dictators. It would be funny because most of those who come to these companies have only a vague idea what to look for, and are absolutely wasting the taxpayers' money because their time cannot by any remote chance be expected to produce useful corrective or properly disciplinary court action.

But despite the unreasonableness, the wastefulness, and the altogether ineffective procedure there seems to be nothing that can be done except to let these minions of "justice" search. Their obvious disappointment at not finding a flagrant violation of the law may at least provide a bit of entertainment.

INTERSTATE BARRIERS DOWN

MOVEMENT OF CEMENT into Florida has been restricted by a duty camouflaged as an "inspection fee" of 15 cents per hundredweight. The Supreme Court thrust aside this labelling of the fee and recognized this as a duty on interstate movement of the goods. As such the court ruled that the state legislature had overstepped its legitimate function and invaded the power of the Federal government by an action which did, in fact, regulate interstate commerce.

Chemical industry has frequently been plagued by such controls based on the theory of inspection or supervision or protection of citizens against fraud or under-quality goods. No legitimate manufacturers have objected to state regulations which really accomplish these commendable purposes. But they have been rightly objecting to those which under the guise of state police power were actually interstate tariffs.

If there remain any cases where such local regulation interferes with the legitimate movement of proper goods, the industries now have means for protecting themselves against such restriction.

OH YEAH?

THE REALIZATION of Edison's dream to make America independent of foreign rubber sources is indicated after many years of experimentation behind guarded doors at the Long Island City research laboratory of Matthew J. Stacom, according to the New York *Times*. Mr. Stacom's experiments have shown that the process, employing his horn-angle machine, makes it possible to extract rubber economically enough to enable castilla rubber, which can be grown in Florida, to compete successfully for the first time with plantation rubber. This is said to be due to the fact that his process will not only extract the rubber from the tree, but will at the same time make the tree yield many valuable products such as cellulose fiber, sugars and resins.

We only wish we could believe that our respected neighbor, the *Times*, were right in its report that finally we have a domestic source of low-price rubber. Unfortunately, Mr. Stacom's name recalls his horn-angle process for making wood pulp which he assured the world would revolutionize the paper industry. But perhaps he was only spoofing after all, for the report was dated April first.

Gasoline by Catalysis

New chemical processes for the manufacture of superior anti-knock motor fuels promise almost revolutionary engineering advances with the use of lower temperatures and pressures and better control of cracking operations. The current construction program calls for expenditures of many millions of dollars for equipment and chemical catalysts.

Houdry unit in the plant of Socony-Vacuum Oil Co. presents an interesting spectacle at night

GEORGE F. FITZGERALD

Chemical Engineer
Olean, New York

STEADILY INCREASING demand for higher octane motor fuels follows logically from the consistent increase in compression ratios. High compression motors must have high-octane fuel in order to develop maximum power from a given weight of fuel. Even third grade automobile fuel has been affected and is now selling with an octane rating of 3 to 5 points higher than two years ago. While the addition of tetra-ethyl lead solves the problem for low grade fuels, it is by no means sufficient for aviation grades. These must generally be made up with a "base" having a quality far superior to ordinary gasoline.

Research into methods for the production of higher-octane fuels has been divided between synthesis and pyrolysis. Since existing processes and products were unsuitable it seemed reasonable to many investigators that entirely different methods were required. To these men we owe the progress made in such processes as polymerization, hydrogenation, catalytic reforming, cyclization and alkylation. They have spent over $5,000,000 in the past three years and have tested more than 500 catalytic agents. That the best chemical engineering practice has been followed is indicated by the use of at least fifty pilot plants here and abroad for studying catalytic processes in petroleum refineries.

Other researchers felt that the cracking operation was the key to the situation but that it should be made more selective under rigidly controlled conditions. Since its inception the pyrolysis of hydrocarbon oils to obtain increased yields of motor fuel has undergone many changes. The original Burton patent for thermal decomposition by batch operation was issued in January, 1913. Later modifications included the addition of tubular heating surfaces and the adaptation of the "bubble tower" type of fractionating column. The Dubbs cracking process covering distillation of oil under self-generated pressure was patented two years later. In close succession came the Holmes-Manley, the Cross and others. All admittedly had points in common thus making the patent situation highly complex.

This very complexity benefited the industry because it led to exchange of patents and cooperation[1] in research which has made possible the perfected systems of today. The old "tube and tank" became eventually the modern combination unit which charges crude oil directly and eliminates all separate installations for distillation, viscosity-breaking of the reduced crude, and high temperature cracking. The improvements made were largely in heat efficiency with some increase in yield and quality. Additional savings have been made in some plants by including vapor-phase treating towers and polymerization plants with the combination cracking. Modern units have so increased the obsolescence rate that it is now profitable to replace equipment less than seven years old. Operating costs for combination units are estimated at about 20c. per bbl. of charge compared with 26c. per bbl. for separate cracking systems.

But the immediate need of the oil industry was for the quantity production of a motor fuel having substantially the anti-knock value of iso-octane (2, 2, 4 trimethylpentane) which is arbitrarily rated at 100. The introduction of such fuels has greatly stimulated aviation. Their importance is shown by the statement of the National Advisory Board: "The continued increase in the power output of aircraft engines is principally obtained by the use of premium fuels having high anti-knock values."

Assurance of an ample supply of fighting grade fuel is essential to any plan for air defense. Fuels of 100-octane have been produced by several methods, the oldest of which is selective polymerization followed by hydrogenation. Our domestic production is sufficient to take care of the present demand from military and commercial aviation. The future demand, however, is expected to increase enormously. Catalytic processes like the Houdry and the U.O.P. will furnish the additional capacity at relatively low costs. Non-catalytic cracking by heat and pressure alone is limited to a yield of about 80–82 per cent of 67-octane product. Ordinary base gasoline made by blending this cracked material with straight-run gasoline cannot be leaded to much above 78 to 80-octane. An accompanying typical curve shows the lead-susceptibility for a common 60-octane base gasoline. (See p. 198).

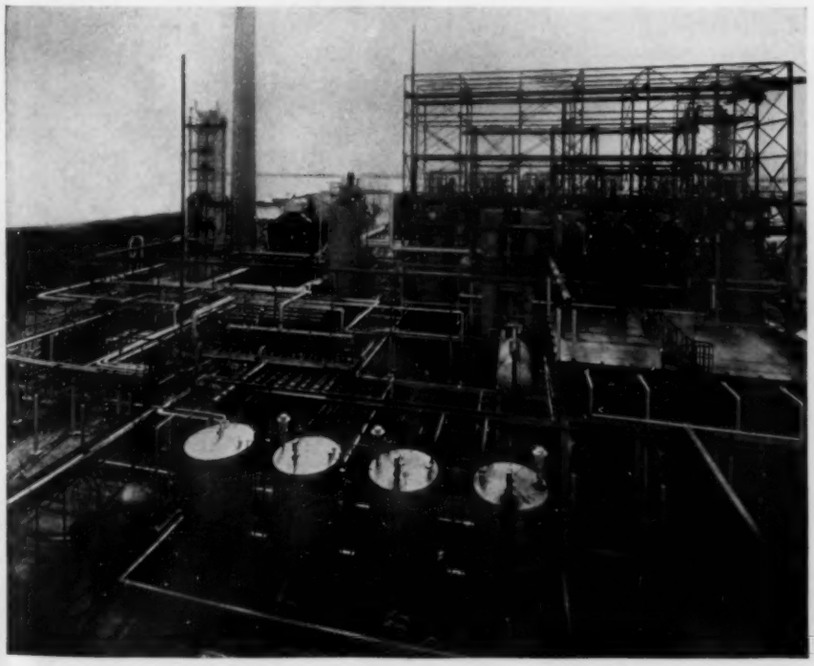
Catalytic cracking in connection with other operations is today producing 80–90 per cent of 80-octane motor fuel from fuel oil distillate (gas oil). This product when blended with thermally cracked and straight-run gasolines has an apparent octane value of 100—i.e., the goal desired. Acceptance of this process by the industry is shown by the activity of six of the largest companies who control over 30 per cent of the total domestic refining capacity. Socony-Vacuum and Sun Oil who officially announced their Houdry Process at the American Petroleum Institute last November[2] are erecting eleven plants at a total cost of over $35,000,000. Standard Oil of California, a recent Houdry licensee, has work under way to apply the process to California crudes.

Steps in the Houdry process when catalytically cracking gas oil are shown in an accompanying flow sheet. The charge to the continuous pipe heater first passes through heat exchangers countercurrent to the catalyst discharge and the residue from the fractionating column. Leaving the heater at 900 to 1,000 deg. F. the gas oil is transferred to one of two catalyst towers. These towers must alternate on stream due to carbon accumulation on the catalyst surfaces. The changeover is made automatically about every 30 minutes or oftener depending on the charge stock. Regeneration is accomplished in place by controlled oxidation through injecting air and/or steam. Provision is made for utilizing the heat of regeneration to develop steam and electric power. The catalyst (activated hydrosilicate of alumina) gives practically unchanged yields after six months to a year in service.

The cracked product leaving the Houdry catalyst tower passes through heat exchangers to a conventional fractionating column where the residual gas oil is removed from the gasoline. This residue, unlike the corresponding product from thermal crackers, is almost identical with the raw feed. It may be cracked again by recycling or by charging to a thermal cracking unit. In the latter case yields will be approximately 50 per cent of a gasoline having better octane than would be obtained from similar virgin gas oils. The accumulated production of gasoline by this dual cracking of gas oil represents very close to 90 per cent of the raw feed.

The Houdry cracking process is unique in that it is applicable to almost any type of charging stock except straight-run gasoline. The yields and quality of product are substantially the same regardless of charge. The finished product has high lead susceptibility and an octane number of 78–80 with excellent blending value. A commercial blend of 75 per cent Houdry aviation gasoline

Marcus Hook refinery of the Sun Oil Co.—where high-octane motor fuel is made from residuum by the Houdry cracking process—viewed from the rear



with 25 per cent iso-octane and less than 3 cc. of Ethyl fluid rated 110-octane by the Army method.

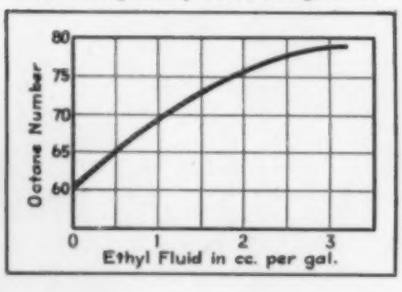
Universal Oil Products Co., licensors of the Dubbs (thermal) cracking processes, are pioneers in cracking research. Through Dr. Gustav Egloff[3, 4] the commercial introduction of their new process for catalytic cracking has only been made public. Consolidated Oil Corp., Shell Union Oil Corp., and Texas Corp. are putting several million dollars into installations for the manufacture of high-octane fuels by this process. Flow through the system follows the course shown in the flowsheet but the process differs in many respects from the Houdry.

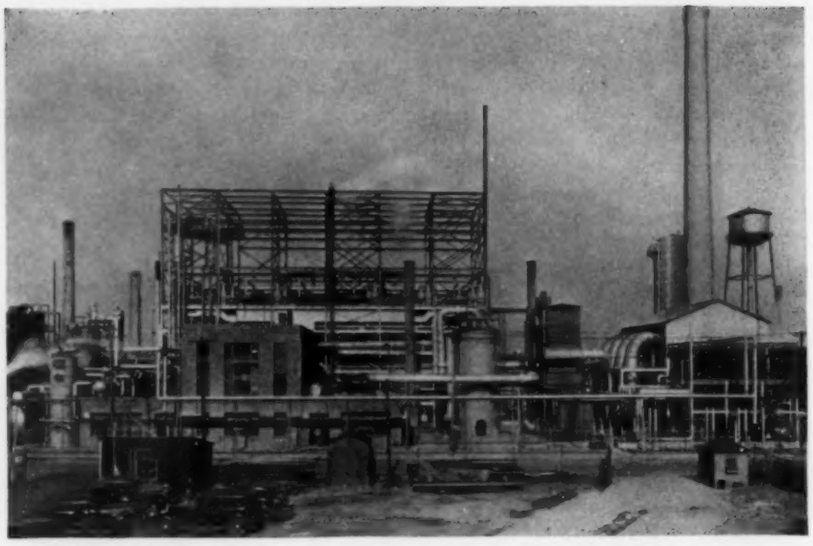
The "solid" phosphoric acid catalyst is in reality silica impregnated with phosphoric anhydride. Originally liquid phosphoric acid was used on a carrier but caused severe corrosion of equipment. With the present catalyst, weak caustic soda is circulated across the bottom of each catalyst header to prevent corrosion by neutralizing any entrained phosphoric acid. By running the charge (highly paraffinic gas oils are preferred) once through the catalytic plant and feeding the residue to a thermal unit maximum yields of 80–82 octane fuels are obtained. Feed to the process also may be recycled at ratios of 1:1, 2:1 or to a maximum yield of motor gasoline. In the latter case the fixed gases produced would be charged to a catalytic polymerization unit to be condensed into iso-paraffines of the C_4 to C_{12} groups having excellent anti-knock properties. Ninety-five per cent of the olefine content of the gas production can be polymerized.

Catalyst towers are in pairs and are regenerated alternately as previously described. Cycles of 30 minutes to 6 hours have been used but the shorter periods are favored since regeneration is correspondingly more rapid. The same catalyst may be kept in service three to four months or longer.

It is the history of thermal cracking that after the field was opened many other new processes appeared. We may logically expect that others will now follow the lead of Houdry and Universal in catalytic cracking. The future may bring improvements to parallel the development of thermal cracking which in twenty-five years grew from nothing to the point where the production of cracked gasoline exceeds that of straight-run. Since the first cracking license was issued the fees have decreased from an original 15c. per bbl. of charge to the current 5c. rate. Concurrent with cracking developments will come improvements in polymerization, hydrogenation and alkylation.

Lead-susceptibility curve for gasoline





Front view of the Houdry Unit of the Sun Oil Co. at Marcus Hook, Pa.

The polymerization of the olefines in refinery gases is already well established with a total operating capacity in excess of 100,000,000 cu.ft. per day and a potential daily production of 25,000,000 gal. of polymer gasoline if all available refinery gases were utilized. This polymer when used for blending is worth to the refiner two to four cents per gallon more than the regular product. Thermal polymerization units give better yields but the catalytic type involves much lower installation and operating costs. The simple design of both catalytic cracking and polymerization plants involves only the use of standard heaters, heat exchangers, fractionating columns and auxiliary equipment. The catalyst towers themselves are fabricated pressure vessels requiring no unusual construction.

Only after thorough proving on a semi-works scale was polymerization offered to the petroleum industry. Since then its rapid acceptance has led to the erection of more than 40 units representing an investment of $15,000,000. The large units charge from 3,000,000 to 25,000,000 cu.ft. of cracking still gases per day. Such gases may contain 40 to 50 per cent of propene and butenes which are readily polymerized at about 400 to 500 deg. F. catalytically or 950 to 1,100 deg. F. thermally. For the best results the charge is diluted with processed gas to 25–30 per cent olefine content. The product consists largely of the C_4 to C_{12} chains with a high degree of isomerization. It is not highly lead susceptible but has an octane rating of 83–85 and a blending value of 108–110. It makes an excellent octane "balancer" in blends with cracked and reformed stocks.

The steps involved in catalytic polymerization are shown in the simplified flowsheet herewith. Regeneration by controlled oxidation, though not shown, is employed in the larger plants. Present figures appear to indicate that ultra-small units will find it more economical to replace exhausted catalyst rather than to install regenerating equipment and additional catalyst towers.

A typical "solid" phosphoric acid unit[5] charging 2,000,000 cu.ft. of gas daily yields approximately 7 gal. of polymer per 1,000 cu.ft. Five catalyst towers are used to permit cutting in and out for regeneration. The charge to the system reaches a temperature of 380 to 400 deg. F. in a pipe heater and then passes from top to bottom of the towers in series where the exothermic reaction raises the tempera-

ture another 100 deg. F. The catalyst bed is regenerated by heating with oxygen-free flue gas to approximately 650 deg. F. and then admitting a controlled amount of air until the oxygen content of the exit gases reaches 5 per cent. Heating with flue gas is repeated to a temperature of 750 and then to 800 deg. F. with controlled oxidation after each heating period. An 800-hour cycle will require 75 hours for satisfactory regeneration.

The feed to this unit contains 30–35 per cent olefines which are selectively polymerized while the paraffine content goes through unchanged. The moisture content of the charge is brought up to about 2 per cent which is the optimum for hydrating the catalyst and insuring complete reaction. The polymer product is slightly corrosive due to entrained phosphoric acid which may be neutralized with dilute caustic soda although tri-sodium phosphate has been found to cause less scale formation.

The propane content is removed in a conventional stabilizer column employing a large number of bubble plates. Reflux is provided by condensing part of the distillate and returning it to the top of the column. At maximum throughput for the polymerization plant it is necessary to employ a second stabilizer acting as a de-butanizer to bring the product down to the required vapor pressure. All recovered propane and butane which has no other outlet is used for fuel or to dilute the polymer feed when fresh catalyst is being used. This precaution prevents over-polymerization and consequent production of heavy, unusable material.

Until recently only large polymerization plants were thought to be economically practical. (See *Chem & Met.*, August, 1938, pp. 412–415). The possibilities of plants suited to small refineries have since been demonstrated[8] by two U.O.P. installations in Michigan. They process as little as 250,000 cu.ft. of cracked hydrocarbon gases a day and produce 2,700 gal. a day of polymer gasoline. Actual plant runs have produced from 30 to 45 gal. of polymer per pound of solid phosphoric acid catalyst.

This small unit appeals strongly to the 135 refiners whose plants are limited to 3,000 to 10,000 bbl. of crude oil per day. Within this potential market a large number of "midget" U.O.P. polymerization plants is sure to be erected.

Polymerization processes serve the very useful function of converting practically waste gases into high-octane blending stocks and thus increasing the actual yield of gasoline from crude by 7 to 8 per cent. This increase in production conserves crude oil and at the same time permits making a profit from gasoline plants which too often were running at a loss. Other catalysts are being developed and are sure to bring out new applications. The Houdry processes include a method for polymerizing by means of the hydrosilicate of alumina agent while the Shell process[7] polymerizes a mixture of normal and iso-butenes in the presence of sulphuric acid. The iso-octenes so obtained are hydrogenated to a fuel nearly equivalent to 2, 2, 4 trimethylpentane. Commercial quantities of "iso-octane" are being produced by this method.

As the petroleum industry turns more completely to chemical manufacturing (See *Chem. & Met.*, September, 1938, pp. 474–477) processes like the catalytic isomerization of staight-chain hydrocarbons to the much more active branched chains will be necessary. Birch[8] and his colleagues report a number of reactions for the alkylation of ring compounds by the addition of paraffine side-chains. The ring compounds (aromatics) needed can also be prepared from short chain olefines by the process of cyclization[9]. Hexane, heptane and octane obtained either by fractionation or polymerization have been cyclized into benzene, toluene and xylene. The catalysts used are the oxides of chromium, molybdenum, vanadium and titanium supported on activated alumina.

In summarizing it may be said that the commercial application of catalytic processes for the manufacture of superior anti-knock fuels has been made necessary by the limitations of thermal cracking. Long-chain hydrocarbons can now be decomposed under mild conditions of temperature and pressure, with excellent control of the reactions. Yields and quality are both improved. Waste refinery gases are being catalytically converted into high-octane gasoline by de-hydrogenating to olefines which are then polymerized and hydrogenated. Selected olefine-bearing gases are polymerized directly, followed by careful fractionation. The prospects are excellent that further important advances will soon be made in this field. The current construction program exceeds anything predicted a year ago and is convincing evidence that the petroleum industry is keeping pace with the developments of its technologists.

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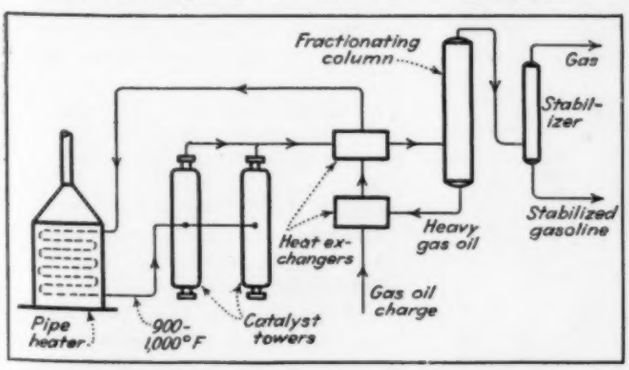
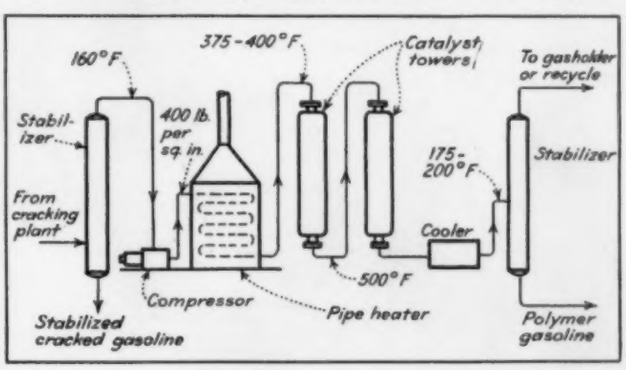
[4] Egloff, Address to N. P. A., Bradford, Pa., Feb. 28, 1939.
[5] Albright, *The Refiner*, Feb. 1939, pp. 41-44.
[6] Arch Foster, *Nat. Pet. News*, Aug. 10, 1938, p. 415.
[7] McAllister, *The Refiner*, Nov., 1937, p. 493.
[8] Birch et al., *Oil and Gas J.*, June 23, 1938.
[9] Morrell, *Oil and Gas J.*, March 16, 1939, p. 55.

Catalytic cracking of gas oil stocks by the Houdry process



Flow sheet for catalytic polymerization of refinery gases



Care and Use of Gas Masks

Last month Mr. Davis described the types of respirators used in the chemical industries, their value and limitations. Now he deals with important considerations in using and caring for chemical filter respirators and hose-line masks.

F. RUTLEDGE DAVIS
President
Davis Emergency Equipment Co.
New York, N. Y.

A GOOD MASK for use with either the chemical filter or the supplied-air type of respirator should have several important characteristics. It should fit tightly without discomfort to the wearer. For greatest comfort, the exhale resistance should be low and the dead-air space small. The inhale tube should be made of very flexible material so that there is no interference with the movements of the head. The mask should be light in weight, but made of tough, durable material so that it will have a long service life.

Masks should be used only by persons trained to their use, and persons working in masks should always be under constant observation. No one wearing a mask should have tobacco, gum, or anything else in his mouth that would tempt him to lift the mask while on the job.

Before putting on a mask, the wearer should examine it for defects and loose connections. After putting it on, he should test it for tightness by pinching the inhale tube and inhaling strongly. If the face piece collapses, the mask can be considered tight.

After the mask has been worn, it should be cleaned and sterilized before being placed in storage. In doing this, the rubber and metal parts are washed with yellow laundry soap and warm water; then they are immersed in a solution of 1 part 40 per cent formaldehyde and 10 parts water or a 2 per cent cresol or lysol solution; and, finally, the masks are rinsed thoroughly and hung up to dry, preferably in a stream of warm, but not hot, air. Never hang masks in the sun, as direct sunlight tends to cause deterioration of rubber parts.

Masks are best stored in separate containers, preferably in cool, dark places, and never in close proximity to steam pipes. A good mask, with proper care, should have several years of service life.

Frequently, masks are provided for use only in case of accident. This means that they may not be used for long periods of time and may possibly be neglected. Since it is of the utmost importance that the masks are usable when the emergency arises, the following steps should be taken in such cases:

1. All masks should be inspected for defects and tested for tightness every six months, and repaired or replaced if found defective.

2. Everyone who may have occasion to use the masks should be trained in their use. Cases have been known where men who had to wear masks did not even know how to put them on, to say nothing of being able to use them safely.

3. Gas masks provided for protection should always be stored outside the threatened area. A gas mask inside a room full of ammonia or other gas is useless.

Wherever there are men working in gas masks, there should be extra masks available in case it is necessary to do rescue work or perform other emergency service. This means that the minimum number of masks to be provided for a one-man job is two. Otherwise it may happen that, if the wearer of the mask is injured while at work, he may have to remain helpless in the toxic atmosphere for a long time before he can be removed.

Motor-and-hand operated blower supplying air to four hose masks

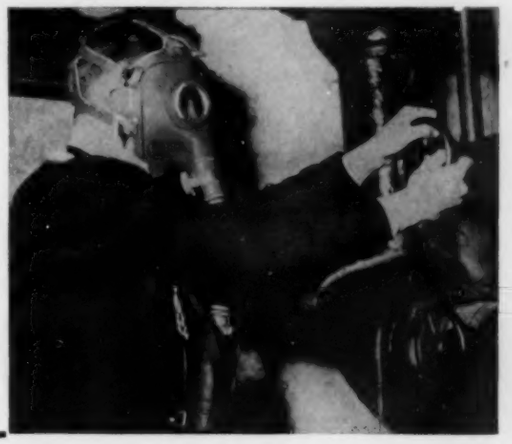
Care of Auxiliary Equipment

Canisters—Canisters as they are received (sealed) from the manufacturer, will last about two years without serious deterioration if kept at an even temperature in air with a relative humidity of 40–60 per cent. In use, the

Left—Hose-mask type respirator, used for gases in high concentrations. Air should be supplied by a blower if hose is more than 25 ft. long, for easy breathing

Above—Respirator with 2,000 cc. capacity canister worn on the back

Right — Canister-type chemical filter respirator for toxic gases, with 650 cc. canister worn on chest



length of life of a canister depends upon its size, the concentration of the gas being absorbed, the humidity of the air, and the rate of breathing, which, in turn, depends upon the character of the work being done. In the case of the less toxic gases the wearer of a canister-type mask may continue to use his canister until he begins to notice traces of the noxious gas in the air he breathes. Then he immediately leaves the gaseous area and secures a fresh canister.

In the case of highly toxic gases, such as hydrogen sulphide, hydrocyanic acid, or carbon monoxide, a definite limit should be placed on the length of time a canister is used, depending on the size of the canister. Special care must be taken with regard to carbon monoxide, since, being odorless, it does not warn the user of the mask that his canister is not absorbing it. For working in this gas, a timer is attached to the mask which indicates when the canister should be changed.

Canisters that have been used but not exhausted can be used again, if their openings are tightly closed and they are stored under proper conditions. A record should be kept of the time that each canister has been used, which will give an approximate idea of its remaining life. In any case, however, a man using an old canister should enter the contaminated atmosphere cautiously so that he will have ample warning if his canister has become useless.

Hose—A good hose for use with hose masks should be so strong mechanically that no accident likely to happen to it, or to the wearer of the mask, will rupture or crush it so that the air supply will be cut off. Special attention should be given to the couplings attaching the hose to the mask and joining the several lengths of the hose together, to make sure that they will not part under any pull to which they may be subjected if the line is fouled or if it is used to pull a man out of the tank. The surface of the hose should be smooth so that it will not tend to catch on obstructions.

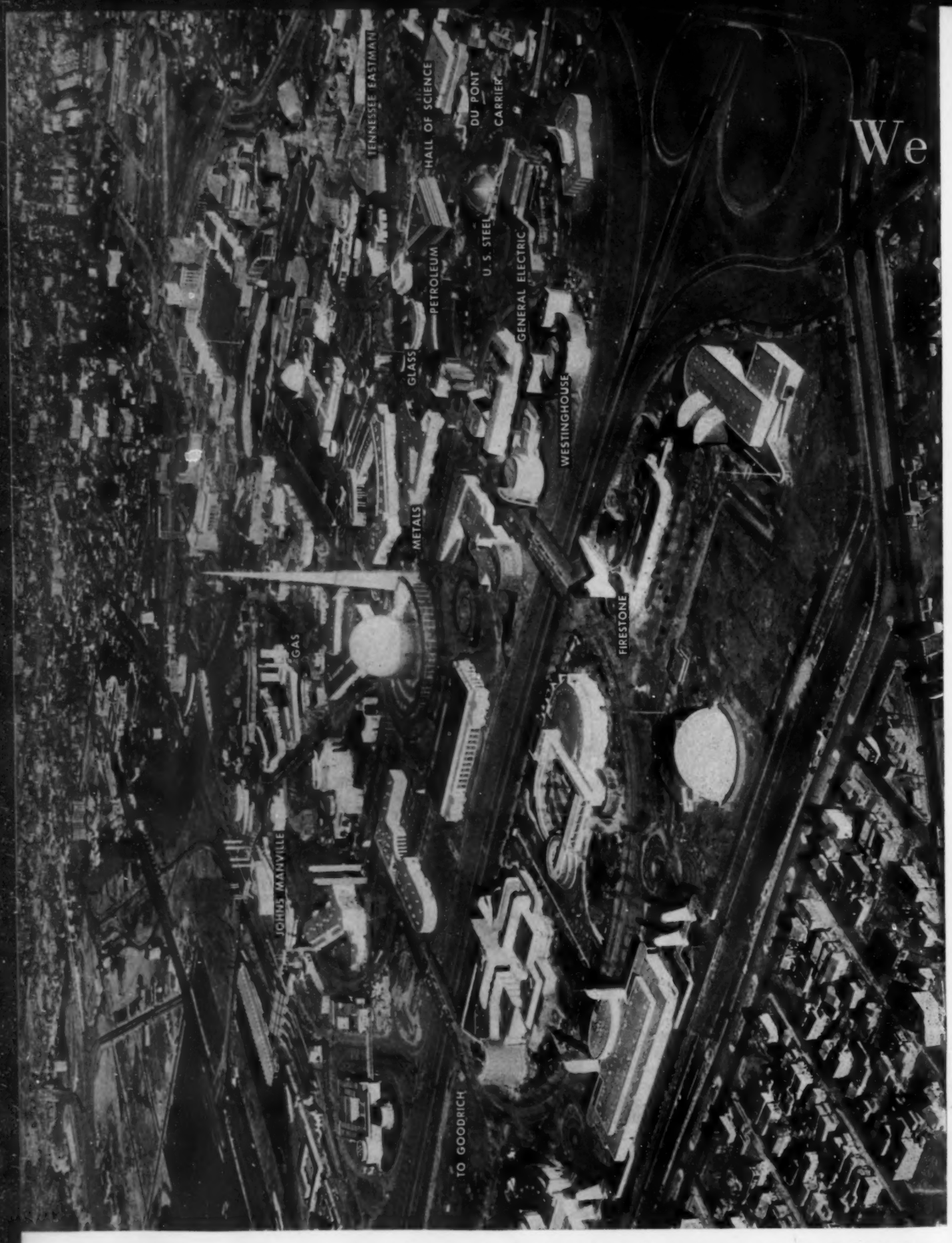
When a man wearing a hose mask enters a confined space, he should always wear a safety belt or harness with a life-line attached and another man should always be detailed to watch him.

All metal parts of hose masks used in flammable atmospheres should be made of non-sparking metal. Hose with the outer covering so worn that the metallic reinforcement is exposed should never be used, especially in flammable gas-air mixtures, as a metal-to-metal contact may cause a spark.

Blowers—A desirable safety feature found on some types of positive-pressure blowers consists of a control valve, which can be set to open when the air in the hose reaches any desired pressure. This valve is set in advance for the pressure required by the number of men served by the blower and the length of the hose line. The blower handle is then operated so as to keep this valve slightly open at all times. Should a leak develop in the respiratory circuit, this valve will close and if it cannot be opened by slightly increasing the speed of the blower, the men being served by the blower should be removed to safety as quickly as is humanly possible.

Resuscitation—Wherever men are liable to be exposed to noxious gases, it is most important that certain, if not all, of them are familiar with the Schaefer prone-pressure method of artificial respiration. By the prompt and proper application of this treatment the lives of victims of even severe cases of gas poisoning can often be saved.

A valuable auxiliary in the treatment of gas-poisoning cases is the inhalator, an instrument for administering to the victim a mixture consisting of from 5–7 per cent of carbon dioxide and from 95–93 per cent of oxygen. The carbon dioxide in this mixture stimulates respiration, while the oxygen provides a much more effective restorative than ordinary air. The timely use of this instrument, plus artificial respiration when breathing has ceased, has saved many thousands of lives.



Some of the numerous points of chemical engineering interest at the New York World's Fair

Go to the World's Fair

EDITORIAL STAFF REPORT

The editors present a preview of the New York World's Fair. This great showcase displays many recent developments of the process industries which chemical engineers will wish to see while visiting the Fair

THE ENTIRE COUNTRY is Fair conscious this year with the Golden Gate International Exposition on the West Coast and the New York World's Fair in the East. Chemists and chemical engineers are scheduled to visit the California Fair August 6-12 on the occasion of the Western Chemical Congress at which time the features of the Fair will be described in *Chem. & Met.* The New York Fair officially opens April 30. Between that date and the end of September when the Electrochemical Society holds its fall meeting in this city large numbers of chemical engineers will no doubt visit the Fair. While they are going to take in these fairs primarily to be entertained most of them will wish to see the recent developments of their own industries that are being displayed in this great showcase. For the benefit of those chemical engineers who expect to come to New York, a preview of the exhibits of some of those companies whose products would be of interest is presented.

One of the purposes of the Fair is to show the Tools of Today with which the Better World of Tomorrow is to be built. On the Avenue of Pioneers, a tower of plate glass and glass brick surmounts the Glass Center. In the great rotunda, where decorative panels depict the history of the industry, the main exhibit features a furnace containing molten glass and manned by a crew of glass blowers. And nearby a continuous fiber machine will produce glass yarn. Corning Glass Works presents an elaborate display of its products including the series "Corning Means Research in Glass," illustrating the company's contributions to modern civilization. Here is shown the largest clear cystal piece of Steuben glass ever made. The The Owens-Illinois Glass Co. displays fiber-glass, glass blocks and containers. Two animated bottles are synchronized with light and sound. The Pittsburgh Plate Glass Co. demonstrates, among other things, the imperviousness of a glass block to heat or cold.

The Metals Building located on the Court of Power contains among others the exhibit of American Platinum Works which displays the palladium catalyst used to convert edible oils into solid fats. Irvington Smelting and Refining Works reveals how gold and silver are freed from dross in the refinery and redistributed to perform vital services to civilization. The uses of copper sulphate are explained. In the Baker & Co. exhibit a method of protecting base metal vessels against corrosion, by covering their surface with platinum will interest the chemical engineer. Platinum spinnerettes and many other pieces of industrial equipment will be shown.

By means of working models, photomurals and dioramas the Link-Belt Co.'s exhibit shows how the use of mechanical conveying equipment for handling materials can expedite production, reduce costs and ease labor's burdens. Various types of driving units are shown in operation. The Timken Roller Bearing Co. displays among its many products a variety of stainless steel products including tubing.

On the facade of the Hall of Industrial Science is a gigantic mural. By means of glass, aluminum and Lucite the artists have fashioned a symbolic picture of chemicals and plastics. The Rohm & Haas exhibit, located in this hall, tells the story of acrylic resins. Here also is the Texas Gulf Sulphur Co. A model of a sulphur atom magnified 1,270 million times features the exhibit.

The visitors will have an opportunity to see at first hand in the Bakelite Corp.'s show how plastics are made. Through colorful, animated displays, this exposition will bring to the public the dramatic story of Bakelite plastics. It will reveal how plastics are making life more enjoyable in a thousand and one ways.

Tennessee Eastman Corp. will show its cellulose acetate plastic products and rayon.

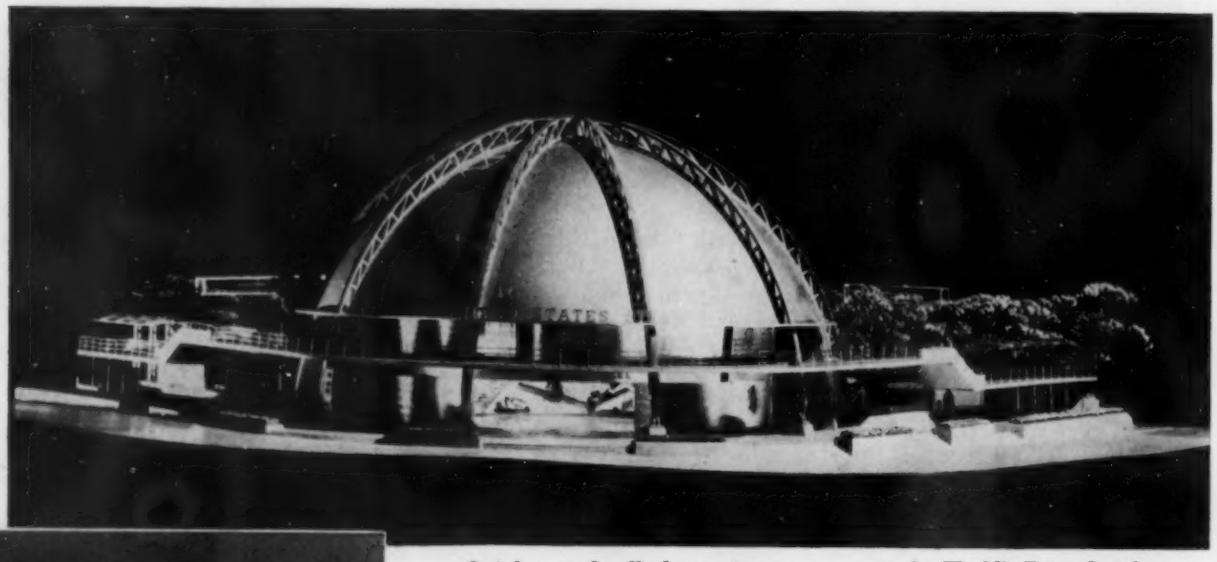
A spectacular tower symbolizing chemical research stands before the "Wonder World of Chemistry," the E. I. duPont de Nemours & Co. build-

ing. The new synthetic fiber, Nylon, and a model nitrogen fixation plant will be shown. The production of the pyroxylin-coated fabric, Fabrikoid, will be demonstrated, and an injection molding machine will show how plastics are made to assume the diverse shapes in which we find them every day. The development of synthetic aromatic bases, and numerous other materials will be demonstrated.

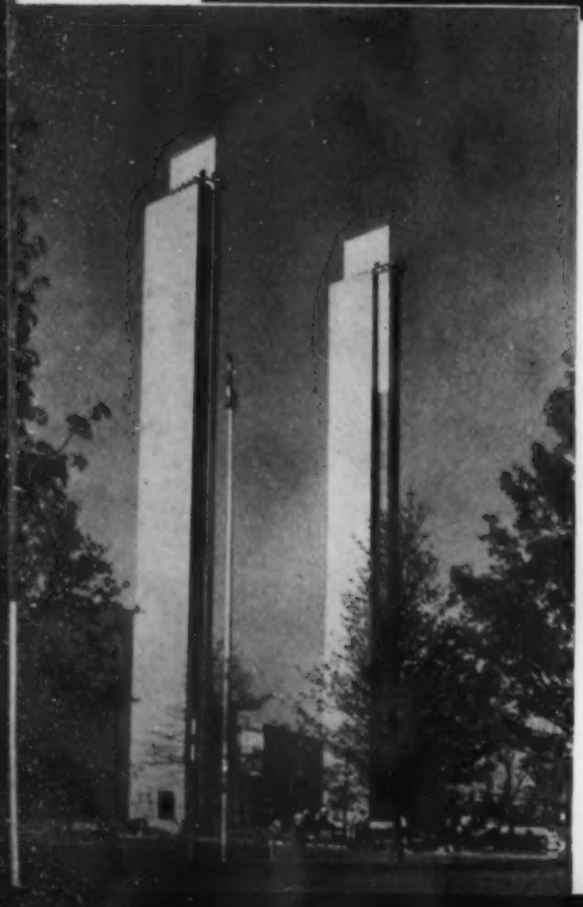
The petroleum building achieves a unique effect with its covering of sheet metal painted in three tones of blue and set in four flaring tiers. All of the exterior metal work is painted with petroleum base paints. The top of the roof canopy is coated with aluminum paint to reflect sunlight and to keep the space beneath cool. An actual oil derrick, towering 200 ft. above the ground and manned with living workers equipped with modern machinery will demonstrate the process of drilling for oil. Four reproductions of oil tanks will partially support the building. One of the principal features of the exhibits will be the Petroleum Garden where modern refining methods will be demonstrated by an animated model of a refinery.

Heating by high frequency induction will be shown in the Westinghouse Electric & Manufacturing Co.'s complete fair in itself. The General Electric Building is distinguished by a huge stainless steel lightning bolt which sets the mood for the exhibit—the taming of the savage natural forces of electricity to serve the needs of men. Johns-Manville will show how asbestos, diatomaceous earth, limestone and asphalt have been transformed into many useful materials of construction for the process industries.

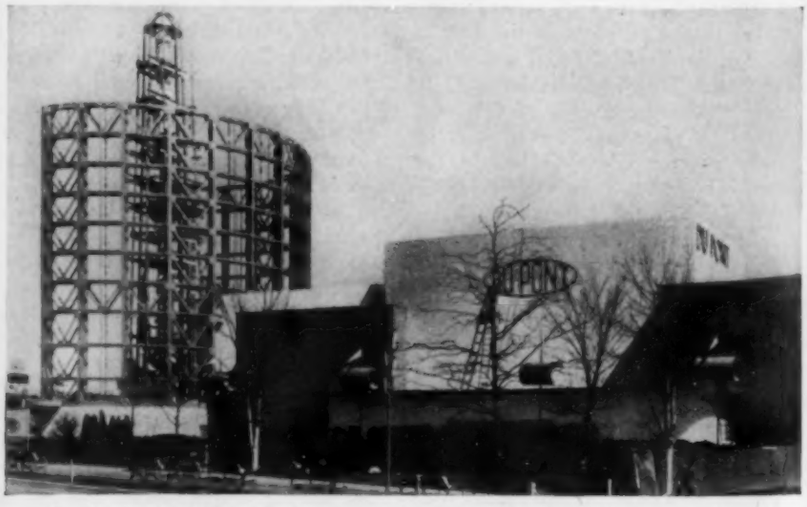
These are but a few of the many features of the New York World's Fair that will appeal to the chemical engineer who wishes to see the products his industries are exhibiting.



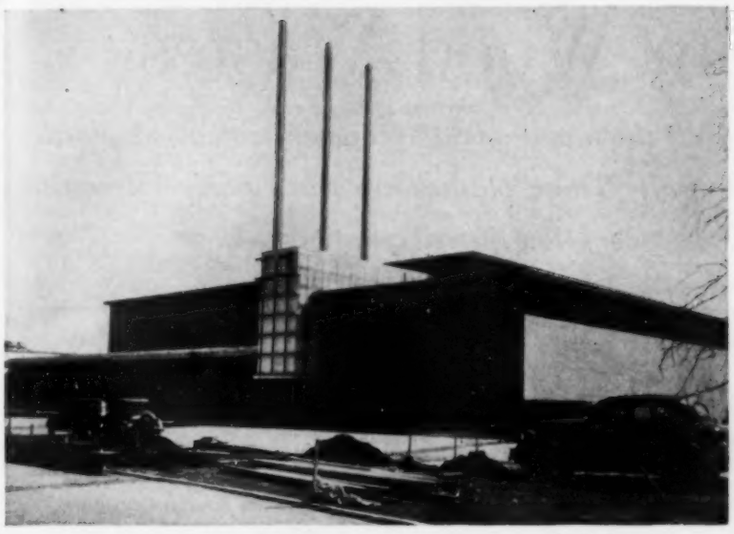
Stainless steel will play an important part in the World's Fair. Stainless steel building erected by United States Steel Corp.



These 145 ft. pylons illuminating area in front of Communications Building are covered with Beetle (urea) translucent laminated resin

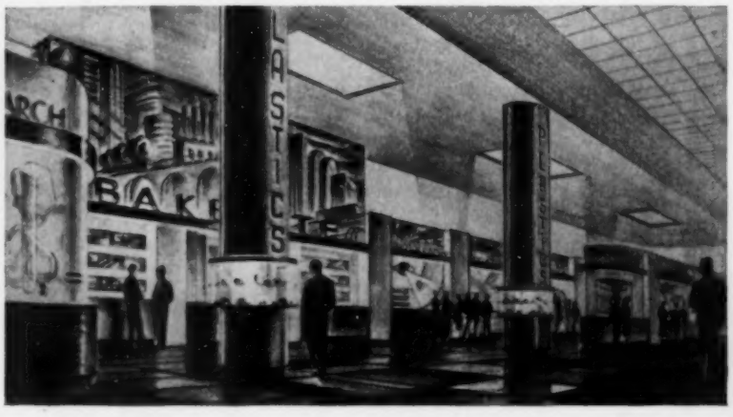


In the E. I. du Pont de Nemours & Co.'s building are exhibits of Nylon, plastic molding, nitrogen fixation, and other products and processes of interest

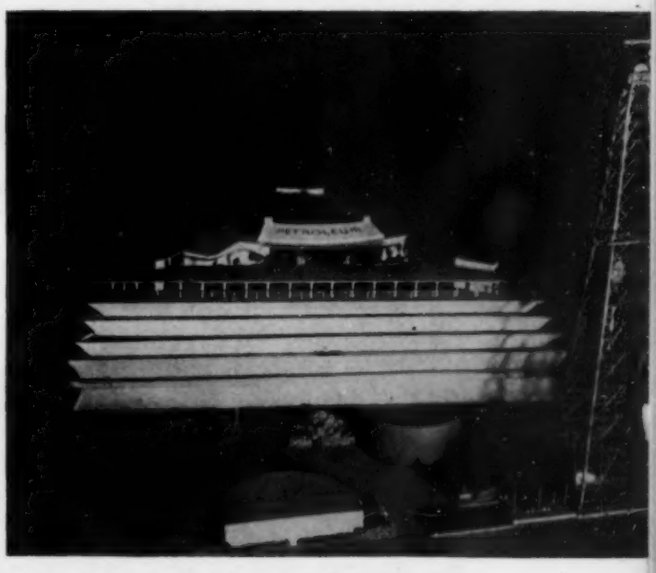


The Hall of Industrial Science is the home of the exhibits of Texas Gulf Sulphur Co., Bakelite Co., Rohm & Haas, Chemical Warfare Service and others

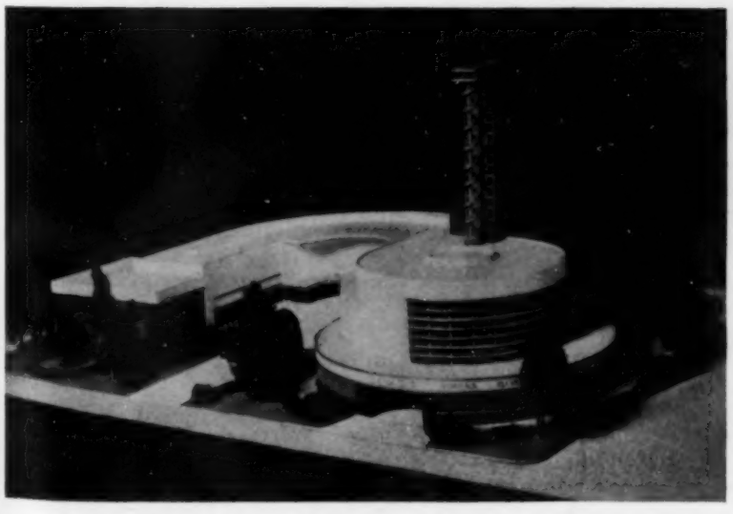
The B. F. Goodrich Co.'s building on the Avenue of Transportation is full of demonstrations that will attract the visitor



Visitors will have an opportunity to see at first hand in the Bakelite show how plastics are made



One of the principal features of the Petroleum Building is the demonstration of modern refining methods. In front is a 200 ft. derrick



The Glass Center contains exhibits of Corning Glass Works, Owens-Illinois Glass Co. and Pittsburgh Plate Glass Co.

Plastics From Wood Wastes

The author discusses the present status of the numerous developments of wood plastics that are under way throughout the country. These plastics are particularly interesting for they offer the greatest possibility of a very low priced plastic product

EDWIN C. JAHN
New York State College of Forestry
Syracuse, N. Y.

ONE OF THE most intriguing problems in wood utilization is that of producing homogeneous plastic materials from wood scraps and sawmill waste. The idea of converting wood scraps into a plastic mass that might be cast into any desired shape is not new. It has been the guiding thought in many attempts to utilize wood waste for the production of so-called "artificial wood" or "synthetic lumber." By the use of suitable binders, ground shavings and sawdust are used to make numerous articles, such as doll heads, furniture ornaments, and novelties. Sawdust mixed with mineral cements is used in making flooring, tiles, stuccos, plasters, insulation materials, and various cast products.

If wood is defibered it can be reformed into fiber sheets of any thickness to make a wide variety of insulating, wall, and hard-pressed boards. The properties of these boards depend upon the fiber structure and the degree to which they were pressed. These structural materials are made in uniform sheets and can be considered a type of "synthetic board." However, they are fiber products and not plastics.

The greatest outlet for wood today in the plastics industry is as a filler in phenolic base molding resins. For this purpose the wood is reduced to a flour. Wood in the form of pulp is also used as a filler or base by mixing it with certain thermoplastic resins. Many ornaments and other articles are made in this way.

The direct plasticization of wood substance into homogeneous fiberless mass which will set and form a hard strong material without the aid of a binder is a much more difficult procedure than its use as a filler or base. True wood lignin plastics, however, can now be produced.

Wood flour is ground, crushed or pulverized wood, screened or air separated to various mesh sizes of particles. It is one of the important constituents in most of the phenolic base molded products and in some of the other synthetic resins. Technical wood flour used in these plastic compounds must be of high quality and in the form of dry granular powders. It is made mostly from clean shavings and sawdust. The wood flour filled resin products are used for such articles as radio tube bases, tube and bottle caps, switch plates, wall plugs, door knobs, telephone receiver sets, buttons, pencil barrels, and many others.

Wood Flour Is Active Ingredient

Wood flour is added to the resin molding powders to give better molding qualities, greater toughness and greater strength. It is entirely possible that the wood flour functions as more than a simple filler. It is likely that some of the constituents of the wood undergo chemical changes with the resin when the mixture is subjected to heat and pressure and the wood flour, therefore, may be an active ingredient in the plastic.

The natural lignin in wood is considered to be a cementing and strengthening material for the tissues. The thought that these properties may be utilized for the preparation of plastics has led to considerable research on the development of lignin plastics.

Our concept of the structure of lignin is still largely one of theory in spite of the accumulation of a great mass of data during the past 30 to 40 years. Most of the formulas presented to depict the structure of lignin are purely armchair attempts to correlate and harmonize the many apparently conflicting observations on the chemistry of lignin. Recently Fuchs[5] proposed an ingenious formula which he considered consistent with the known properties of spruce lignin. Fuchs' molecule has a molecular weight of 782, 4 methoxyl groups, and 4 hydroxyl groups, one of which is phenolic.

Hibbert and co-workers[3] have studied lignin isolated by various means and they conclude that spruce lignin has a definite "building unit," of a molecular weight of 872. This lignin has 5 methoxyl groups and 5 free hydroxyl groups, 3 of which are aliphatic, one is acidic (phenolic or enolic since it reacts with diazomethane and the product is insoluble in caustic soda) and one is characterized by its ease of reaction with alcohols in the presence of hydrochloric acid.

Hilpert[7] has gone so far as to question the existence of lignin in plants. He suggests that the material called lignin is the result of the interaction of carbohydrates and the chemicals used to isolate lignin. Hibbert[6] vigorously opposes this view on the basis that lignin products containing aromatic groups may be isolated and lignin may be extracted by organic compounds under conditions causing no humidification of sensitive sugars.

Probably much of the confusion in the lignin literature is due to non-uniformity in the methods of separation of lignin. The above statements are not a review of the considerable recent literature on lignin, but illustrate the extent of the lignin problem.

Regardless of its constitution, lignin has certain properties which form the basis of its ability to be made plastic. It appears to have a certain measure of unsaturation. Lignin also will condense with phenols, amines, aldehydes and certain other organic compounds to form condensation products which are resinous. The preparation of these resins has been investigated by the Bureau of Chemistry and Soils, Washington, D. C., and by the Forest

Read before the Fourth International Conference on Timber Utilization, Brussels, Belgium, Sept. 15-17, 1938, and printed in the International Review on Timber Utilization, No. 2/3, Brussels, Jan., 1939.

Products Laboratory, Madison, Wis. Interesting products are described, some of which are thermoplastic and form dark brown or lustrous black, hard, fairly strong resins. Phillips and Weihe[10] prepared a number of lignin resins, which when dissolved in organic solvents, yield attractive wood stains.

At the Forest Products Laboratory Sherrard, Bateman, and their associates[1,4] have developed promising lignin plastics by the partial hydrolysis of wood and hot molding of the residue. The wood residue left after partial hydrolysis of the cellulose with dilute sulphuric acid is ground to a powder and pressed at 3,000 lb. per sq. in. at 190 deg. C. It is stated that such a powder could be produced for about one cent per pound[4]. It is found best to add 6 to 8 per cent each of aniline and furfural to the hydrolyzed wood before molding. Digestion of wood under pressure in water and aniline also yields a material which may be molded. These lignin-type plastics are hard, black, take a high polish, are fairly strong, and may be produced cheaply.

A Plastic From Exploded Wood

A patent has recently been assigned to the Masonite Corp.[9] for producing a molding composition from wood. This is essentially an adaptation of the Masonite process for making "exploded" fiber by subjecting chips to a steam pressure of 1,000 lb. per sq. in. and suddenly releasing the pressure. It was found that some hydrolysis of the cellulose took place. This led to the development of the high pressure and temperature hydrolysis process. The time is short and the time variable limited. A variation of one second is enough to cause the difference between failure and success and one-fourth second will produce definite changes.[2]

The heat treatment and explosion reduce the wood to a partly fibrous and partly amorphous mass. This may be dried, ground and molded directly or it may be formed into thin sheets, which are piled together and hot pressed. For a one-eighth inch piece about 20 sheets are pressed for five minutes at 175 deg. C. and 1,500 lb. per sq. in. Black, hard, vitreous-like, water-resistant products result. The Masonite Corp. has built a plant for producing the uncured material for molding.

At the Idaho School of Forestry the author and associates prepared lignin plastics containing one to two per cent of combined sulphur. These plastics are thermosetting and yield products that are hard, capable of taking a glossy polish, and have a strength comparable to some commercial plastics.

In the manufacture of hard pressed boards from wood fibers it is uncertain whether or not certain of the wood constituents, such as the lignin, fuse and act as a cement or binder. In any event, when wood fibers or particles are subjected to proper conditions of heat and pressure they adhere to each other.

At the Idaho institution products have been made in this way from sawdust which are stronger than the original wood. Removal of the natural resins from the wood causes a marked increase in the strength of the molded wood, indicating that coalescence is mostly a surface phenomenon. This is also borne out by the fact that strength increases with decrease in particle size.

Natural Resin Increases Strength

The presence of natural resin decreases the strength because it readily melts forming a film around the particles, preventing their being fused together. The natural resin is weak and readily fractures.

When cellulose is comminuted in water or swollen in a strong solution of zinc chloride or sulphuric acid, the regular orientation of the colloidal crystallites in the fiber is decreased. The fiber becomes swollen and gelatinous. When such gelatinized fibers are compacted together there is no sharp distinction between the disorganized surfaces of each fiber. This results in a more or less continuous physical form throughout the mass. This is the principle employed in welding together paper fibers to make vegetable parchment and vulcanized fiber. The gelatinization of wood, however, is more complicated than is the case with cellulose due to the presence of lignin and other wood constituents.

Many technical difficulties in the laboratory preparation and molding of gelatinized wood have been overcome in studies at the Idaho School of Forestry.

Gelatinized Wood

The material before molding is paste-like in consistency. It is, therefore plastic when wet and before drying. It is not thermoplastic. In the wet state before molding it may be readily dyed, the wood being in a highly absorbent state. Colored products may be molded in this way. All properties vary directly with the degree of gelatinization.

Molded gelatinized wood may be sawed and worked with tools. The wet paste may be mixed with sawdust or shavings to form boards of low density. When boiled in water the material softens, but does not swell or change shape.

The plastic properties of wood and lignin have been established in numerous experiments and are indicated in certain commercial products, such as hard pressed fiber boards and hot pressed, partially hydrolyzed, steam exploded wood. Plasticized wood has many valuable properties.

Sawmill wastes offer an ideal cheap source of raw material for the manufacture of homogeneous plastic products and "synthetic" structural materials. The laboratory products made from sawdust have valuable properties and it is possible that much improved processes and products may be developed.

Strength and Density of Wood Plastics

Product	Modulus of Rupture (Lb./sq. in.)	Modulus of Elasticity (Lb./sq. in.)	Specific Gravity
Western white pine wood [8]...	5,200 (green) 9,500 (dry)	1,170,000 (green) 1,510,000 (dry)	0.36 (green) 0.38 (dry)
Commercial hard pressed fiber board[3].	6,320	635,000	1.12
Molded wood, after partially hydrolyzing at high pressures and temperatures (2,9)	7,500-20,000	1,500,000	1.35-1.45
Lignin-furfural-aniline plastic from hydrolyzed sawdust [4].	6,000		1.35-1.41
Coalesced wood particles, 20-60 mesh.	3,575	653,157	1.35
Coalesced wood particles, above 100 mesh.	5,151	808,225	1.35
Coalesced wood particles, above 100 mesh, resins removed by extraction.	10,500-12,250	1,280,000-1,320,000	1.40
Lignin plastics.....	7,000-8,000	740,000	1.35-1.40
Molded gelatinized redwood.	17,500	1,710,000	1.3-1.5
Molded gelatinized western	14,250-20,000	2,140,900	1.3-1.5

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Forced Convection Cooling Towers

This third and last of Mr. Simons' series of articles on water cooling towers deals with a method for computing the slat-surface requirements of a mechanical-draft tower employing a new type of packing. An article in February discussed fundamentals, while in March the subject was design of a slat-packed atmospheric tower.

EDWARD SIMONS
Engineer
Redwood Manufacturers Co.
San Francisco, Calif.

AS A PARTICLE of matter within a gas or liquid changes its point position in the fluid, the heat contained in the particle also changes position. When heat is transferred by moving matter, the method of conveying the heat is known as convection. When the particle motion within the fluid is caused only by differences in density arising from temperature differences, the convection is natural. When the fluid motion for heat transfer is produced by forces which are external to the temperature-density system, the convection is forced.

The atmospheric cooling tower operates by natural convection during periods of dead calm, and by forced convection during periods of wind action. Water-cooling towers with mechanically produced convection are used most generally where wind action is unsatisfactory and where size limitations preclude the use of towers of the atmospheric type. The air currents are supplied by fans. When the air must pass through the fans before cooling the water, the tower is of the forced-draft type; when the air passes through the fans after cooling the water, the tower is of the induced-draft type. The cooling surface is either in drop form or in sheet form.

When air and water are in contact, there exists a thin film of gas in which the flow is non-turbulent and laminar. Reliable data indicate that the portion of the air film which is in contact with the water surface is saturated at the temperature of the water film.[1e 2] For packed towers with fixed sheet surface, one may employ the assumption that the coefficient of total heat transfer through the liquid film to the interface between the gas film and the liquid is so great that the temperature at the interface equals the bulk temperature of the main body of the water; this procedure introduces a practical approximation.[1b]

It has been demonstrated[3] that

$$\frac{h}{kr_w} = \left(\frac{s_a M_A}{r_w M_L}\right)(B - p_w) = Z \quad (1)$$

Inspection of Equation (1) will indicate that the ratio h/k is practically constant for a given wet-bulb. The diffusivity is directly proportional to the square root of the absolute temperature; therefore, k is directly proportional to the square root of the absolute temperature.[1e] As the temperature increases, Z increases as indicated on Chart III. Also, $r_w Z = h/k$ increases. Therefore, since k increases with temperature increase, and since h/k also increases with temperature increase, it follows that h must also increase with temperature increase.

Where R_c is the instantaneous rate of cooling at water temperature t_c,[3]

$$R_c = v_c k_c A (p_c - p_a) - h_c A (t_a - t_c) \quad (2)$$

The fundamental psychrometric relationships of temperature, pressure, and heat exchange exist in the saturated gas film adjacent to the interface. However, the value of h in the gas film may not equal the overall value of h applying through the gas film and into the turbulent cooling air. If the value of h in the gas film is h_c, and if h_c is assumed as the overall value of h through the film and into the turbulent air, study of Equation (2) will indicate a rate of cooling which is too high when the water is warmer than the air. Since, however, it may be demonstrated that variation in h_c does not cause serious inaccuracy in analysis for practical design, the assumption which has been outlined will be employed.

The fundamental psychrometric equation may be written:[3]

$$p_c = p_w - Z_w t_a + Z_w t_w \quad (3)$$

Furthermore, the value of

$$h_c / k_c r_c = Z_c \quad (4)$$

Hence Equation (2) may be rewritten

$$R_c = r_c k_c A (p_c - p_a - Z_c t_a + Z_c t_c) \quad (5)$$

A substitution in Equation (5) of the value of p_a shown in Equation (3) gives:

$$R_c = r_c k_c A (p_c - p_w + Z_w t_a - Z_w t_w - Z_c t_a + Z_c t_c)$$

$$R_c = r_c k_c A [(p_c + Z_c t_c) - (p_w + Z_w t_w) + t_a (Z_w - Z_c)] \quad (6)$$

The value of the quantity $(Z_w - Z_c)$ is very small; inspection of Chart III will demonstrate this statement. If Z_w is set equal to Z_c, $(Z_w - Z_c)$ disappears from the equation, and $Z_c t_c$ is is reduced by t_c $(Z_c - Z_w)$. Furthermore, $r_c k_c$ will be replaced by K', which is determined experimentally for an average water temperature during cooling of 83 deg. F. The effect of k_c in Equation (2) is thus reduced.

If a gas is heated at constant pressure, the number of molecules of the gas per unit volume is decreased in inverse proportion to the absolute temperatures of the gas before and after heating. The kinetic energy of each molecule, however, is increased, since fewer molecules must maintain the bombardment that produces the unchanged pressure.

If a piece of lumber is passed through a planer at a fixed feed velocity, a certain amount of wood will be planed off when the knives on the cutting head are cutting at a basic velocity of rotation. If the feed into the cutters is maintained constant and the velocity of the rotation is decreased, less wood will be removed because the bites of the individual knives will be spaced farther apart. However, if the setup of the machine is altered to take a deeper cut, and if

Nomenclature

A	= Area of cooling surface which acts when rate of cooling is R_c, sq.ft.
a	= Constant in straight line equation for K', B.t.u. per sq.ft., min., and in. Hg difference.
B	= Barometric pressure, in. Hg, taken as 29.92 in.
b	= Constant factor in straight line equation for K', B.t.u. per sq.ft., min., in. Hg difference, and ft. per min. air velocity.
D_c	$= p_c + Z_w t_c$, in. Hg.
D_w	$= p_w + Z_w t_w$, in. Hg.
E, E_c, E_d	= Ratios of evaporative cooling rate to total cooling rate at t_c, t_{ac}, and t_{ad} respectively.
F	= Flow loading, g.p.m. per sq. ft.; equals Q/LWm.
h, h_c	= Coefficients of sensible heat transfer through the gas film at $(t_a - t_w)$ and $(t_c - t_a)$ respectively, B.t.u. per sq.ft., deg. F. temp. diff., and min.
H_c, H_{ac}, H_{ad}	= Humidity of air at t_c, t_{ac} and t_{ad} respectively, lb. water vapor per lb. dry air.
k, k_c	= Coefficients of mass transfer of vapor at $(p_a - p_w)$ and $(p_c - p_a)$ respectively, lb. per sq.ft., min. and in. Hg diff.
K	= Overall coefficient of heat transfer based upon mass velocity of air stream, B.t.u. per sq.ft., min., and in. Hg difference.
K'	= Value of K at average air temperature of 75 deg. F. (Chart IV).
L	= Length of tower cell, ft.
M_A	= Molecular weight of air.
M_L	= Molecular weight of water vapor.
m	= Number of cells in tower.
N	= Rate at which vapor pressure of wet-bulb increases for each 10 B.t.u. increase in "sigma function" of 1 lb. dry air, in. Hg. (Chart II).
p_a	= Actual vapor pressure of water vapor in air at t_a, in. Hg.
p_w, p_c	= Saturated vapor pressure at t_w and t_c respectively, in. Hg.
Q	= Flow of water through cooling tower, U. S. gal. per min.
r_w, r_c	= Latent heat of water vapor at t_w and t_c respectively, B.t.u. per lb.
R_c	= Instantaneous rate of cooling of water at t_c, B.t.u. per min.
S	= Total cooling surface in tower, sq.ft.
s_a	= Specific humid heat of the air and water-vapor mixture at t_a, B.t.u. per deg. F., and lb. of dry air.
t_a, t_w, t_c	= Temperatures of the dry-bulb, wet-bulb and water, respectively, deg. F.
t_{cc}, t_{cd}	= Temperature of water before cooling and after cooling, respectively, deg. F.
t_{ac}, t_{wc}	= Dry-bulb and wet-bulb temperatures, respectively, of air entering tower before start of cooling, deg. F.
T_{av}	= Average absolute temperature of air throughout tower, deg. Rankine.
T_a	= Absolute temperature of air, deg. Rankine.
Δt	= Temperature increment in design, deg. F.
V_e	= Linear velocity of air entering tower, ft. per min.
V	= Linear velocity of air in straight line equation for K', ft. per min.
W	= Width of tower cell, ft.
Z	= General value of h/kr_w, in. Hg per deg. F. See Equation (1) and Chart III.
Z_w, Z_c	= Values for Z at t_w and t_c.
Σ_{wc}	= Total heat of air having wet-bulb temperature of t_{wc} (excluding heat of the liquid at t_{wc}), B.t.u. per lb. dry air. (Chart I).
Σ_{wd}	= Total heat of air having wet-bulb temperature of air leaving tower (excluding heat of the liquid at the wet-bulb temperature), B.t.u. per lb. dry air. (Chart I).

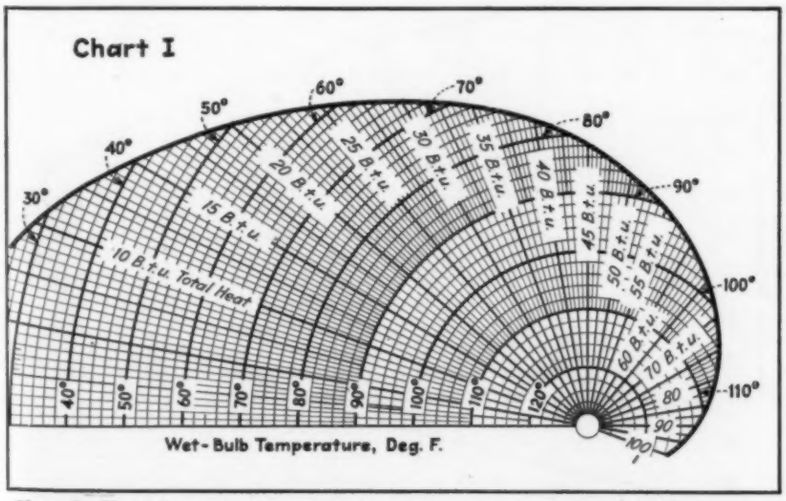


Chart I—Total heat of air-water vapor mixtures for various wet-bulb temperatures (not including heat of liquid), B.t.u. per pound of dry air

sufficient additional power is supplied to the knives, the increased depth of the cut will tend to compensate for the fewer cuts which can be taken at the reduced rotation of the knives.

In the case of the action of an air stream on a gas film, the linear velocity of the air corresponds to the feed velocity of the planer; the reduction in the number of molecules after heating corresponds to the reduced rotation frequency of the cutting knives; and the increased molecular energy due to heating corresponds to the increased power which is supplied to the knives for the deeper, less frequent cuts. K' is therefore influenced by the mass velocity of the cooling air; the influence would appear to vary as a power of the mass velocity which is less than one. Tests on certain types of apparatus indicate that the assumption of variation with the first power of the mass velocity is satisfactory.[14] The values of K' indicated by Chart IV are for air at an average temperature throughout the tower of 75 deg. F., or 535 deg. Rankine (abs.). If T_{av} is the average absolute temperature of the air stream during cooling and V_e is the velocity of the air first passing over the cooling surface, K is the value of K' at a velocity of $(535V_e/T_{av})$.

With the above discussion as a basis, Equation (6) is rewritten:

$$R_c = KA\,[(p_c + Z_w t_c) - (p_w + Z_w t_w)] \quad (7)$$

If $(p_c + Z_w t_c)$ is set equal to D_c, and $(p_w + Z_w t_w)$ is set equal to D_w, Equation (6) becomes

$$R_c = KA\,(D_c - D_w) \quad (8)$$

i.e., the basis cooling rate equation.

The sketch of Fig. 1 shows the shape and arrangement of the Remco Ovate cooling surface (pat. pend.) made by the Redwood Manufacturers Co. The shape of the slat element and the arrangement of the slats provides the following advantageous conditions during operation:

1. Since the resistances to air flow at various operating velocities are small, the first cost and operating charges of the fan motors are small.

2. The water spreads readily over the surfaces of the streamlined guiding surfaces and an intimate, efficient film is developed for contact with the air stream.

3. The entrainment loss in this type of sheet-surface cooling is less than in an apparatus which operates by drop-surface cooling; the power requirements for operation against the resistances of drift eliminators are relatively small.

The clearances at the various sections of the slats are: (1) 1.99 in.; (2) 1.88 in.; (3) 1.78 in.; (4) 1.71 in.; (5) 1.65 in.; (6) 1.62 in.; (7) 1.63 in.; (8) 1.70 in.; (9) 1.89 in.; (10) 2.20 in. If each of these clearances is expressed as a fraction of the slat spacing, 2½ in., and the average taken of these fractions, it is found that the average open area within the packed space is 71.7 per cent of the gross cross sectional area. Hence, the average effective air velocity through the packing is 1/0.717 = 1.395 times the velocity through the gross tower area. The effective perimeter per cubic foot of tower filling is $5.75/12 \times 12/2.5 \times 12/3.125$ = 8.83 sq. ft. per cubic foot.

Chart IV indicates values of K' with ovate filling, for various air velocities at an average air temperature of 75 deg. F. K' is an overall coefficient which is used to calculate cooling action from the bulk of the water to the cooling air. Curves are given for three loadings. The values of K' are based upon the assumption that neither the flat tail of the cross section of the slat nor the water streams between slats are active cooling surfaces; in other words, K' is applied to the surfaces of the effective perimeters of the slats, and the effect of the cooling action of any other surface is recognized when K' is applied from the proper loading basis. When the loading falls below 1.7 g.p.m. per square foot of gross horizontal sectional area of the tower, the distribution efficiency is reduced.

Chart IV also shows the results of experiments by Carrier and by Coffey and Horne. In these tests, evaporation occurred with the liquid at the wet-bulb temperature. Carrier's evaporator was a large bulb,[4] while the evaporator of Coffey and Horne was a "lozenge-shaped" container in which the abrupt surface changes of the true lozenge were modified with curvature in order that the air streams might have intimate contact with the wick of the evaporating surface.[5] The differences in size and shape between the evaporator of Carrier and that of Coffey and Horne would naturally result in different experimental results.[1,6] However, it is interesting to note that there is a decrease in the rate of cooling as the thickness of the water sheet increases. Furthermore, the indicated values of K' are for air velocities with respect to a fixed cross section of the apparatus. As the amount of water to be cooled is increased, the velocity of the water through the tower increases. Therefore, for a fixed air velocity, the velocity of the water with respect to the air is increased as the tower water load is increased. The values of K' indicated on Chart IV are average values obtained by test.

Inspection of Chart IV will indicate that the variation of K' with respect to the velocity V may be assumed as a straight line variation over portions of the relationship curve. Thus, if the form of the variation is taken as $(K' = a + bV)$, the average value of K' applying over a varying surface will be the value at the average velocity. The average effective velocity of the air stream along the ovate surfaces of Fig. 1 is found by multiplying the air velocity over the gross tower area (filling absent) by the factor 1.395, as shown above.

Designing a Forced Draft Tower

A mechanical convection tower is to be designed for ovate slats with the conditions as follows: $t_{ce} = 82$ deg. F.; $t_{cd} = 74$ deg. F.; $t_{ae} = 70$ deg. F.; $t_{we} = 60$ deg. F.; $Q = 350$ g.p.m.; $F = 2.5$ g.p.m. per sq. ft. $= Q/LWm$; $V_e = 300$ ft. per min.; and $B = 29.92$ in. Hg. Then $Q/F = LWm$, or 350/2.5 = 140 sq. ft. The number of cells m is taken equal to four; thus, the area of each cell is 35.0 sq. ft. Ovate slats manufactured from commercial lengths of 6-ft. lumber may be finished with an active length of 5 ft. 11 in. The cell length will be taken as 5 ft. 11¼ in. In all, 29 ovate slats will occupy a width of 5 ft. 10⅞ in.; the addition of ¼ in. to this dimension yields a cell width of 5 ft. 11⅛ in.

The area of each cell is then 35.2 sq. ft. and the total active horizontal tower area LWm is 140.8 sq. ft. The quantity of entering atmospheric air is

Fig. 1—Redwood Manufacturers Co. Ovate cooling surface slats (pat. pend.)

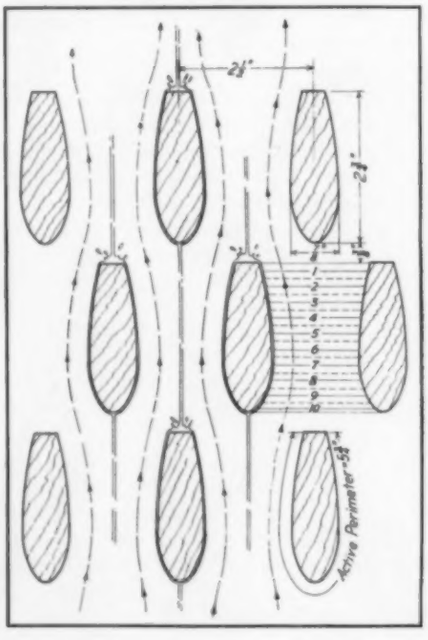
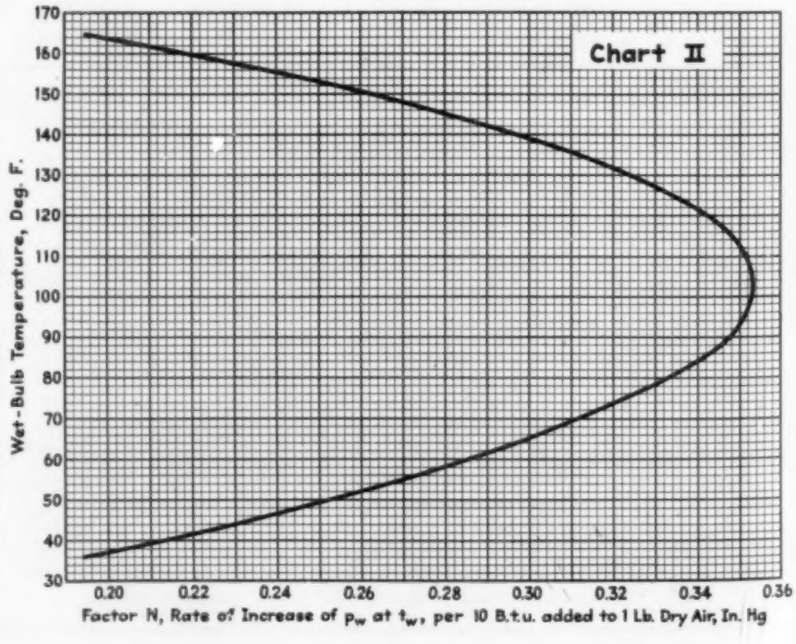


Chart II—Rate of increase of vapor pressure of water vapor in air per 10 B.t.u. added for each pound of dry air, at various wet-bulb temperatures



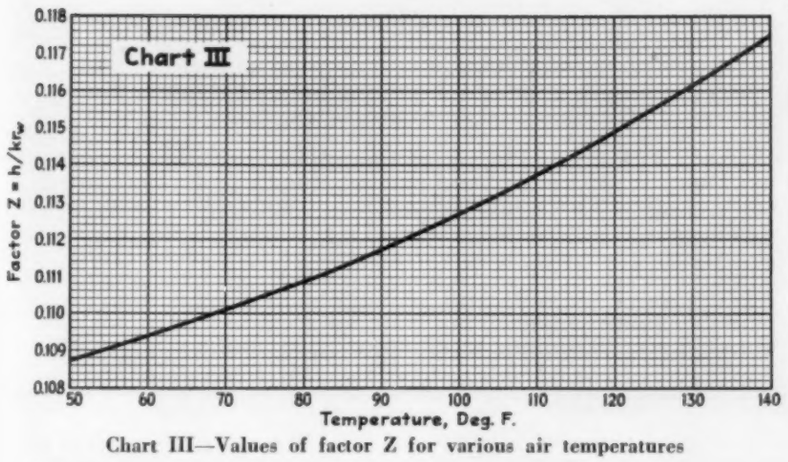


Chart III—Values of factor Z for various air temperatures

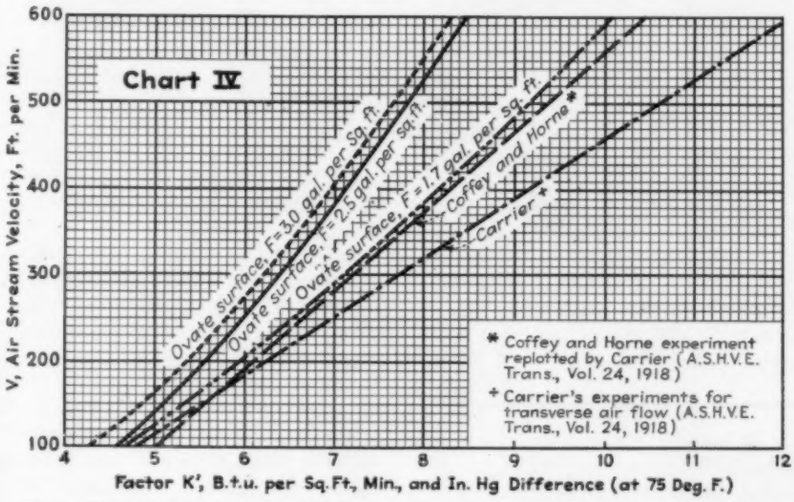


Chart IV—Values of factor K' for various air velocities and water loading rates in a tower employing Ovate filling

$V_e\ LWm = 300 \times 140.8 = 42{,}240$ cu. ft. per minute.

The value of p_a is calculated by the use of Carrier's equation[7a] in the form $p_a = p_w - (B - p_w)\ (t_a - t_w) \div (2{,}800 - 1.3t_w)$. Here $p_w = 0.5214$; $(B - p_w) = 29.40$; $(t_a - t_w) = 10$; $(2{,}800 - 1.3t_w) = 2{,}722$. Therefore $p_a = 0.5214 - 29.40 \times 10 \div 2{,}722 = 0.4134$ in. Hg. The saturated vapor pressure at $t_a = 70$ deg. F. is 0.7387 in. Hg. Therefore, the per cent relative humidity is $100 \times 0.4134/0.7387 = 56$.

The pounds weight of moisture associated with 1 lb. of dry air is $0.622p_a/(B - p_a)$ or $H_a = (0.622 \times 0.4134)/29.507 = 0.00872$ lb.[7b]

The volume of the air and water gases at 32 deg. F. is 359 cu. ft. per volume molal.[1f] The absolute temperature in deg. Rankine is $460 + t_a = T_a$ deg. abs.

The weight of 1 mol of air is 28.97 lb., and the weight of 1 mol of water vapor is 18.02 lb. The volume of 1 lb. of dry air at 70 deg. F. is $(359 \times 530)/(28.97 \times 492) = 13.35$ cu. ft. The volume of 0.00872 lb. of water vapor at 70 deg. F. is $(359 \times 0.00872 \times 530)/(18.02 \times 492) = 0.19$ cu. ft. Therefore, the humid volume of 1 lb. of dry air plus the associated water vapor at 70 deg. F. dry-bulb and 60 deg. F. wet-bulb is $13.35 + 0.19 = 13.54$ cu. ft. per lb. of dry air.

The weight per minute of dry air which passes through the tower is $42{,}240/13.54 = 3{,}120$ lb.

The weight of water circulated is $350 \times 8.33 = 2{,}916$ lb. For each pound of dry air circulated, there will be $2{,}916/3{,}120 = 0.935$ lb. of water. Therefore, since the cooling range is $t_{ce} - t_{cd} = 8$ deg. F., the total heat increase per pound of dry air is $0.935 \times 8 = 7.48$ B.t.u. The total heat, or "sigma function," of the air is shown on Chart I, and for a wet-bulb of 60 deg. F., $\Sigma_{we} = 26.0$. Hence, at the discharge, Σ_{wd} is $26 + 7.5 = 33.5$, so that from Chart I it is evident that the wet-bulb temperature of the leaving air is 70 deg. F. The air leaving the tower may be considered as nearly saturated, so that the average temperature of the air will be assumed as 70 deg. F.

K is then taken as the value of K' for $V_e \times 1.39 \times 535/(460 + 70) = 300 \times 1.39 \times 535/530 = 421$ ft. per min. The numerical value of K' at 2.5 gal. loading and a velocity of 421 ft. per min. is shown to be 7.28 in Chart IV. Since the "sigma function" is constant for a constant wet-bulb temperature,[8] Chart II may be used to calculate the wet-bulb variation throughout the tower. As above, on the basis of 1 lb. of dry air, the heat increase in B.t.u. for a water temperature change of Δt is $0.935\ \Delta t$. Therefore, the increase in vapor pressure at the wet-bulb temperature for $\Delta t = 1$ deg. F. is $0.935N/10 = 0.0935N$.

It is now convenient to set up a table in which the air and water conditions can be calculated for various cross sections of the tower. As in the tabulation given here, the tower is divided into eight sections, the boundaries of which differ by 1 deg. F. of water temperature. The difference in

(*Please turn to page 217*)

Table I—Calculations for Slat Area Required in Eight Sections of Tower

	t_c (1)	N (2)	N_{cs} (3)	$0.0935N$ (4)	p_w (5)	t_w (6)	$Z_w t_w$* (7)	D_w (8)	$Z_w t_c$* (9)	p_c (10)	D_c (11)	$D_c - D_w$ (12)	A (13)
H_2O in.....	82.0	0.312	0.311	0.0291	0.7445	70.2	0.7708	1.515	0.9004	1.1013	2.002	0.487	412
	81.0	0.309	0.307	0.0287	0.7154	69.1	0.7587	1.474	0.8894	1.0661	1.956	0.482	831
	80.0	0.305	0.304	0.0284	0.6867	67.9	0.7455	1.432	0.8784	1.0316	1.910	0.478	838
	79.0	0.302	0.301	0.0282	0.6583	66.6	0.7313	1.390	0.8674	0.9983	1.866	0.476	842
	78.0	0.299	0.297	0.0278	0.6301	65.4	0.7181	1.348	0.8564	0.9659	1.822	0.474	845
	77.0	0.295	0.294	0.0275	0.6023	64.1	0.7038	1.306	0.8455	0.9345	1.780	0.474	845
	76.0	0.292	0.290	0.0271	0.5752	62.8	0.6895	1.265	0.8345	0.9040	1.739	0.474	845
	75.0	0.288	0.286	0.0267	0.5481	61.4	0.6742	1.222	0.8235	0.8745	1.698	0.476	842
H_2O out.....	74.0	0.285	.....	.....	0.5214	60.0	0.6588	1.180	0.8125	0.8456	1.658	0.478	419

Total $S = 6{,}719$ sq. ft.

* From Chart III values of Z_w at 60 deg. and 70.2 deg. F. are 0.01094 and 0.01102, respectively. Average Z_w is 0.01098.

New Aids to Filtration

If you have a difficult problem in filtration the solution may be the use of one or the other of these new types of perforated rubber or rubber-like materials. The holes are formed by the expansion of air through a film of latex.

Two recently developed perforated rubber products should find niches for themselves in the process industries. Multipore is a perforated rubber sheet and microporous hard rubber is an ebonite product permeated by continuous interconnecting pores of microscopic and submicroscopic size. These twins are products of the research laboratories of the U. S. Rubber Co.

The outgrowth of development work has been a modified form of microporous rubber which is sufficiently flexible that it can be folded on itself without breaking. Indications are that this material has the properties required of a filter medium. It has the same degree of resistance to corrosive chemicals as has ordinary hard rubber.

This product can be made with varying degrees of porosity, average pore size and permeability. The grade which is believed to be most suitable for general filtration purposes has a porosity of 65 to 70 per cent and average pore diameter of 2 to 4 microns. Such filter diaphragms of thickness of 0.040 in., operated at 25 in. vacuum, have permeabilities represented by the passage of water through them at rates ranging from 5 to 20 gal. per min. per sq. ft. of diaphragm. Other types are available which have average pore diameter as small as 0.1 micron.

For filtration work under pressure the material is made with reinforced construction. The reinforcing materials are preferably fabric of high chemical resistance such as woven asbestos or stainless steel although cotton duck may be used. This is bonded to the microporous rubber sheet as a backing. The composite material has much greater tear resistance and bursting strength than the unreinforced material, and its permeability is not reduced thereby.

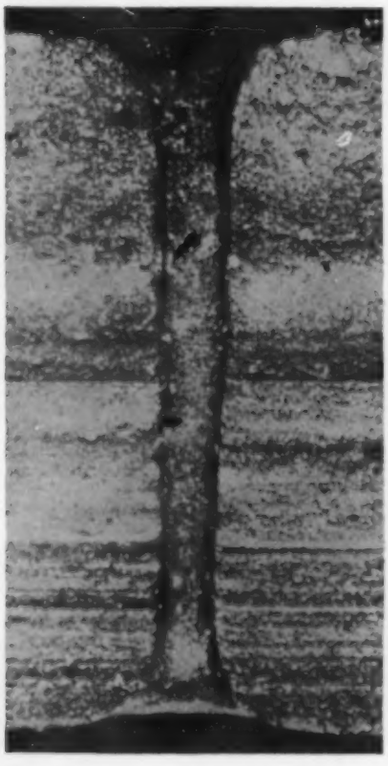
Filtration tests of microporous hard rubber in comparison with a standard duck have indicated superiority in speed of filtration, retention of fine precipitates, non-clogging of the pores and ease of removal of the filter cake. Material of this type will be available in widths to 50 in., lengths to 100 yd. and in gages from 0.030 to 0.10 in.

It was originally developed as a separator for storage batteries where inertness to 30 per cent sulphuric acid and low electrical resistance are of utmost importance. These same properties should make this material of interest in other electrochemical processes, such as semi-permeable diaphragms used in electrolytic plating and refining cells and in the electrolytic production of hydrogen and oxygen.

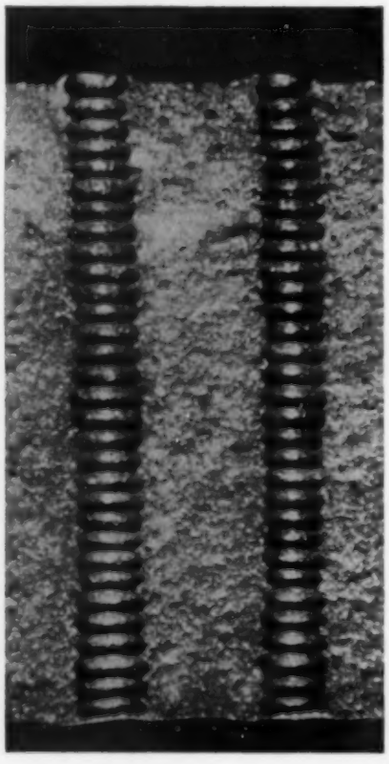
Multipore is a porous rubber sheet made from latex rubber, deriving its characteristics from many minute and uniformly spaced holes that extend perpendicularly through the sheet.

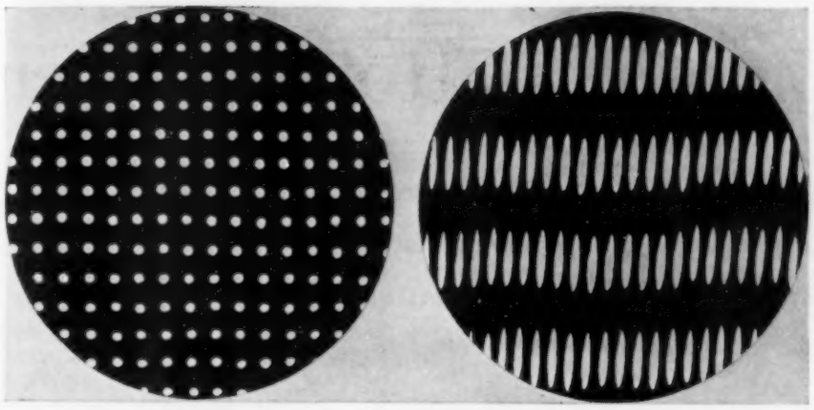
Cross-sectional views of holes

Perforations made in sheeting made by punching



Holes in Multipore are made by expansion of air in latex film





Plain Multipore, 3200 holes per sq. in., pore diameter .005–006 in.

3200-hole hard rubber Multipore expanded 250 per cent in one direction

The types now produced commercially have 1,100 to 6,400 holes per sq. in. and pore diameters of 0.012 to 0.004 in., depending upon the type. At present it can be obtained in soft rubber, hard rubber, flexible hard rubber, and Neoprene.

This material is not mechanically perforated sheeting. The holes are formed by the expansion of air through a film of latex. It is said to have many advantages over the mechanically prepared product.

In the plain type of Multipore, holes are round and extend perpendicularly through the sheet. It can be obtained with a fabric backing firmly adhered to one side, with little loss of porosity. A wide variety of fabrics can be used and by a suitable choice, the stretchable characteristics of the rubber-fabric combination may be controlled.

If the unvulcanized multiporous material is first stretched in either one or both directions and vulcanized under stretch, the product is known as expanded Multipore. Depending upon the degree and type of stretch, a wide variety of products of the expanded type can be made which are characterized by oval holes and higher porosity. In some cases porosities as high as 30 per cent can be obtained.

In view of the fact that the smallest pore diameter is 0.004 in. it might be assumed that this material would retain only coarse particles. It is a fact, however, that if a suspension or slurry contains some coarse particles, these bridge across the pores and retain the fines. The rate of cake formation on 3,200 hole material is the same as for common type of canvas filter cloth. The rate of cake formation on expanded Multipore is greater than for the plain product, as could be expected.

Multiporous material is made on a heavy fabric belt surfaced on one side with a layer of rubber. The surface contains uniformly spaced pits approximately 0.020 in. deep and closed at the bottom. The number of pits per unit area and the diameter of the pits at the surface of the blanket determine the porous properties of the product, and are subject to control in regard to both size and number per unit area. The blanket is placed with the pitted surface up, as an endless belt on a modified spreading machine. A thin layer of latex is applied to the belt by a spreader bar. The air is trapped in each pit, and when heat is applied to the under surface of the blanket by a steam platen, and as the belt becomes hot the air in the pits expands, blowing bubbles through the film of latex. The rubber film is thoroughly dried in a drying chamber, the belt is again cooled on a drum and the process repeated as many times as are required to obtain the desired thickness.

Properties of Flexible Microporous Hard Rubber

	Type LEx	Asbestos Reinforced Type LExo
Porosity (% voids by volume)	76	75
Average pore size (microns (a))	2	2
Ash, % by weight	2.0	2.0 (b)
The following data apply to diaphragms .040 in. thick:		
Tear resistance, A.S.T.M. (lb.)	0.15	14.1
Mullen bursting strength	24	76
Water permeability (gal./min./sq. ft. at 25 in. vacuum)	16.6	15.0

(a) 1 micron = .00004 in.
(b) Ash exclusive of asbestos backing.

Porous Characteristics and Maximum Dimensions of the Types of Plain Multipore

# Holes/ sq. in.	Av. Hole Diameter	Calc. % Voids	Available Thicknesses*	Max. width of sheet	Max. length of sheet
6,400	.004–.005 in.	8–10	.030 in.	42 in.	38 yd.
3,200	.005–.006 in.	6–7	.030 in., .050 in., .070 in., .090 in.	42 in.	38 yd.
1,700	.005–.007 in.	5–6	"	42 in.	38 yd.
1,100	.010–.012 in.	10–13	"	42 in.	38 yd.

* The thicknesses listed in this column are standard. Other gages can be produced on special order at additional cost.

Filter Test Data, Microporous Rubber vs. 18 oz. Duck No. 8

(a) Continuous filtration under 25 in. vacuum to determine rate of build up of cake.

	Titanium Oxide Pigment				Ground Iron Ore			
	Microporous Rubber LEx		18 oz. Duck #8		Microporous Rubber LEx		18 oz. Duck #8	
Time of Filtering Cycle (min.)	Filtrate gal./sq. ft.	Cake lb./sq. ft.	Filtrate gal./sq. ft.	Cake lb./sq. ft.	Filtrate gal./sq. ft.	Cake lb./sq. ft.	Filtrate gal./sq. ft.	Cake lb./sq. ft.
1	.232	1.55	.211	1.29	.112	.81	.095	.78
2	.328	2.21	.275	1.83	.152	1.11	.131	1.08
4	.465	3.13	.400	2.82	.233	1.61	.192	1.65
7					.290	2.38	.237	2.10

(b) Filtration tests, 25 in. vacuum, with cycling consisting of 1 minute cake formation, 3 minutes dewatering, 15 cycles per hr.

	Microporous rubber		Filter cloth
	LEx	Abestos reinforced LExo	18 oz. Duck #8
Water permeability of medium, gal. min. sq. ft.	16.5	15.0	17.0
Tests on 45% suspension of ground chalk in water:			
dry cake yield, lb./sq./ft./day	530	522	480
Per cent solids in filtrate	.02	.02	.08

Factors in Choosing a Rotary Dryer

Most industrial thermic drying is done by one of five methods: spray, drum, tunnel, rotary vacuum or rotary atmospheric. The last named is the method discussed here. All of the salient features and many of the peculiarities, advantageous and otherwise, of the several types of atmospheric rotary dryers are covered in detail.

H. W. HARRIGAN *and* J. A. BOYD
Drying Machinery Division
Hersey Manufacturing Co.
Boston, Mass.

ROTARY DRYERS are broadly similar in that they consist of a rotating shell, the inside surface of which is usually equipped with shelves or buckets to lift and shower the material being dried through a current of high temperature gases—either combustion gases or heated air—or over tubes carrying steam or other heating medium. At one end of the shell, unless it is a steam tube dryer, is a solid fuel, oil or gas furnace or a steam coil and the opposite end is usually connected to a suction fan. A stack is sometimes used instead of the fan to produce draft in direct heat dryers but the fan gives better draft control and is to be preferred. The fan is required with a steam tube dryer only to exhaust the vapor as evaporated, although usually some air is carried to permit the drying to be done at a lower material temperature than would be possible otherwise. Dryers may be of either direct or indirect heat type and many variations of both types are used. A few of them are described in this article.

Any type dryer may use either counter or concurrent flow of heating medium and material. The former is ordinarily to be preferred because the mean temperature difference between heating medium and material is much greater for any given initial and final temperatures of both. This results in a faster heat transfer; hence drying is more rapid and a shorter dryer may be used. Also a greater temperature drop in the heating medium can usually be obtained so that more of the heat originally contained therein is used for drying and the efficiency is higher.

However, it is frequently necessary to use the concurrent system when the material is of such a nature that it would be injured by exposure to high temperatures when almost or completely dry. This is especially true of materials which are not divided into particles of uniform size. The small pieces reach dryness first and as they cannot be separated and removed from the dryer they will, in a countercurrent dryer, be exposed to progressively higher temperatures and eventually may be decomposed or scorched. In a countercurrent dryer, these finer particles are retarded by the flow of gases, whereas in the concurrent system the speed of the lighter particles through the dryer is accelerated.

Concurrent Uses Hotter Gases

Directheat concurrent dryers may use gases at temperatures up to 1,000 deg. F., without using refractory lining or special heat-resistant steel, because the hot gases on entering come in contact with cold wet material and heat is exchanged rapidly, causing a sharp drop in gas temperature.

Regardless of temperature, any drying that may be satisfactorily done in dryers using either counter or concurrent flow system, will be accomplished more easily and cheaply in the former than in the latter.

Illustrated in Fig. 1 is a special oil-fired dust-proof apparatus having tubes through which combustion gases pass. It was designed for use on either very fine materials or materials not harmed by high temperatures but which must not come in contact with the products of combustion. The dust-proof feature protects bearings and other wearing surfaces from floating abrasive dust.

It will be noted that two fans are used, one for the combustion gases and the other to remove the vapor. Since the vapor exhaust fan causes any air leaks in the dryer to be inward, the dryer itself does not add to the dust problem. Any dust carried out of the dryer by the fan is precipitated in an air washer. One fan could suffice if the proper dampers and their controls were applied but the arrangement shown does not require expert attention and was chosen for that reason. It will also be seen that recirculation is employed to economically reduce the temperature of the combustion gases. Using additional air for this purpose would cause a large loss of heat carried out in the exhaust gases.

A hot air dryer is shown in Fig. 2. As illustrated, atmospheric air is heated by passing over steam coils. An alternative is to use flue gases to heat the air by means of a heat exchanger. This type of dryer is the best for materials which must be dried at low temperatures, say from 100 to 150 deg. F. The discharge temperature of the material will usually be under 130 deg. and can be controlled to a large extent by varying the quantity and temperature of the air used.

Fig. 3 shows a dryer with the addition of a steam cylinder at the center of the shell. (This dryer may be used with or without hot air.) It is useful for materials that will not subdivide readily and will not be injured by steam temperatures. The

material is dropped on the cylinder and remains an appreciable time which results in better absorption of heat than could be obtained with limited exposed surface from air or gases.

Fig. 4 shows a dryer in which a bundle of steam tubes replaces the cylinder. One make of dryer using steam tubes rotates the shell around stationary tubes and another uses the reverse design, rotating the tube bundle within a stationary shell. The stationary tube type is suited only to materials which flow quite freely, as otherwise the spaces between the tubes would become clogged and the dryer would cease to function. The principal advantage is the elimination of stuffing boxes. The other type may be used for somewhat more sluggish materials since if it does not sift through, it will be spilled off the tubes as they revolve. If the material is very free flowing, such as grains, etc., and an adequate supply of air is used to prevent conditions approaching saturation, these dryers can accomplish the work at fairly low material temperatures, though somewhat higher than with the hot air type of dryer. With this exception, they are best used for materials which will not be injured by temperatures approaching that of the steam.

A type of indirect heat dryer not so commonly used, is shown in Fig. 5 in which a single steam tube spirals around the inside surface of the shell. This dryer is suited to handle about the same class of material as the dryer shown in Fig. 3 and, in common with all dryers in which the heating medium is separated from the material, it is also satisfactory for very light materials. Very sticky materials cannot be satisfactorily processed in rotary dryers but for such materials as may be best handled in this type, the advantages are (a) continuous flow, (b) no operators needed, (c) product discharged in marketable form, (d) low operating cost and (e) long life.

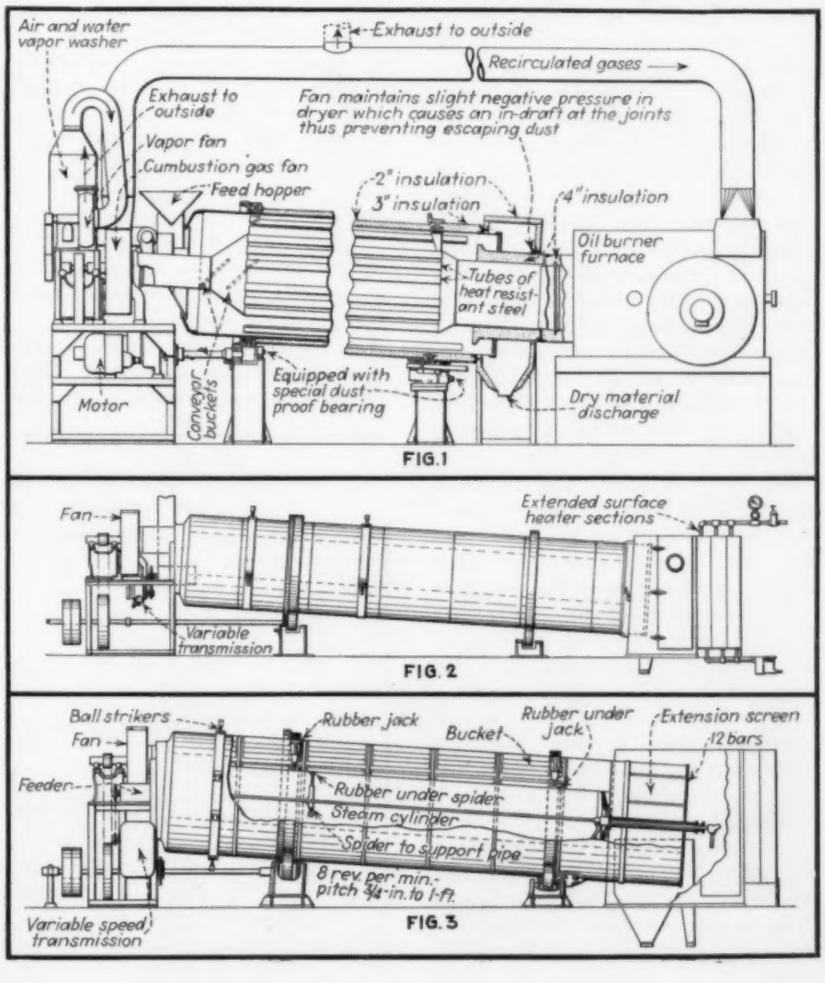
The efficiency of various sizes of rotary dryers—one a direct heat, concurrent flow type using recirculation of gases, and the others of the hot air countercurrent type—may be learned from a study of the values given in the accompanying table of performance data.

The thermal efficiencies given in the table are not the true efficiencies of any of the dryers but rather constitute coefficients indicating the proportion of the total heat that is used

Dryer Performance Data—Hourly Basis

Material	Forage (Alfalfa)	Potato Starch	Confec. Starch	Cane Sugar	Salt
Size of dryer, ft.	6 x 33	3 x 30	3 x 20	6 x 23	6 x 33
Pitch of dryer (In. per ft.)	None	.5	.29	.75	.5
Dryer r. p. m.	11	18	18	12	9
Type of dryer	Direct heat Con-current	Hot air Counter-current	Hot air Counter-current	Hot air Counter-current	Hot air Counter-current
Relative flow of air and material					
Feed rate, lb	5,250	1,140	7,200	23,700	13,400
Output, lb	1,980	780	7,030	23,150	12,700
Water evaporated, lb.	3,270	360	170	550	630
Initial moisture content of material, per cent	67	43.5	7.6	2.62	5.1
Final moisture content of material, per cent	12.5	17.4	5.36	.31	.42
Initial temp. of material, °F.	76	55	78	109	62
Final temp. of material, °F.	197	109	154	120	117
Air (gases) used, lb.	5,860	12,120	8,875	19,340	23,700
Ambient temp., °F.	78	73	91	82	70
Ingoing (heated) air temperature, °F.	1,100	292	300	285	276
Exhaust air temp., °F.	283	102	115	126	107
Fuel oil consumed, gal.	39.5				
Steam pressure, lb. gage		90	100	85	74
Steam condensed, lb.		718	503	1,050	1,300
Heat balance, B.t.u.:—					
To heat the air "A"	5,530,000	630,500	442,000	933,000	1,160,000
Given up by the air in dryer	5,030,000	547,000	391,000	731,000	952,000
Used to heat solids	125,800	10,430	136,500	76,160	142,700
Used to heat remaining water	30,000	7,350	30,650	790	2,950
Used to heat evap. water	438,200	16,930	6,290	9,350	28,350
Used for evap. and heating H_2O vapor	3,285,000	372,700	174,700	562,000	650,160
Total required for drying "B"	3,879,000	407,410	348,140	648,300	824,160
Losses by radiation and convection and overcoming hygroscopic attraction	1,151,000	139,590	42,870	82,700	127,840
Lost in exhaust air	500,000	83,500	51,000	202,000	208,000
Thermal efficiency, per cent (Eff.:100::B:A)	70	64.7	78.8	69.5	71

Fig. 1 illustrates a special oil-fired dust-proof dryer designed to handle either very fine materials or materials not harmed by high temperatures but which must not come in contact with products of combustion. Fig. 2 is a hot air dryer, best suited to materials that must be dried at low temperatures. Fig. 3 is a steam cylinder dryer useful for materials not easily subdivided



for the more easily determined requirements. Radiation and convection losses are not always readily determined, consequently they have been bulked together in the table with the separation of hygroscopic work which is not a heat loss, but an academic figure that none but the most thorough tests reveal. If these quantities were each considered where they belong, the efficiency shown would be higher in all cases. This fact will be easily understood by noting the performance of the potato starch dryer. The starch was dried at a low temperature and kept the dryer shell cool so that radiation and convection losses were comparatively small. An excellent air temperature drop was also obtained so that this dryer was perhaps really operating more efficiently than any of the others.

Any countercurrent flow rotary dryer using combustion gases or hot air as the drying medium will give uniform results only when operated 24 hours a day. Obviously, to obtain uniform results the material must receive uniform treatment which is impossible where intermittent operation prevails. Theoretically it is not possible even in continuous operation. If the dryer and its accessories start to function simultaneously, the first material entering the dryer meets hot gases all the way through, abstracts some heat therefrom and surrenders some moisture thereto so that the material immediately following does not receive exactly the same treatment. It is a case of a variable approaching but never reaching its limit. In practice, however, small variations occur and external changes take place and the limit line is crossed and recrossed.

It seems like an anomaly, but is worthy of note that, all other factors being equal, a dryer using hot air or gases will dry a material that comes to the dryer cold, more efficiently than one that comes to the dryer at a higher temperature, but more heat will be required in the former case than in the latter. This is assuming the efficiency to be the ratio of the heat required to accomplish the work to that imparted to the air, and is the usual basis. It is accounted for by the greater air temperature drop obtained when drying colder material.

The efficiency of the same dryer will vary within rather wide limits with variations of ambient temperature. Obviously, if the air has to be heated from a low temperature, more heat will be required to do it, and, since the drying will be done at only a slightly lower material temperature because of the lower air humidity, only a slightly greater air temperature drop will be obtained and a larger percentage of the heat will be carried out in the exhaust air. Also, more heat will be lost by radiation, etc., but this will be the lesser loss.

The weight of gases specified as used for the forage drying was only that of the fresh products of combustion introduced. About 12,000 lb. of gases were recirculated per hour so the total quantity of gases available to carry the heat was in the neighborhood of 18,000 lb. per hour. This may seem like a low figure, but is easily explained by the large percentage of water vapor present, which, of course, has a much higher specific heat than the other gases. The radiant heat losses were rather high when the test was made as the dryer had to be put in operation before being properly insulated. This dryer illustrates the advantages of concurrent flow of gases and material and recirculation of gases for such material. Since the dryer was level, the material travelled through it only because of the propelling force of the gases. The heavy portions remained in the dryer about 1½ minutes and the very light portions were carried through in a few seconds. All the material was properly dried and not injured in any way. Recirculating the gases had a double value, (1) the temperature of the combustion gases was economically reduced with the resulting advantages previously enumerated; (2) the oxygen content of the gases was maintained below that which would support combustion and any fire hazard was thereby eliminated.

Some authorities claim that if concurrent flow is used in a direct heat dryer, the temperature of the outgoing gases should be kept well above 212 deg. F., as otherwise condensation may take place and the material again become wet. This does not seem reasonable. Reference to the performance data of the forage dryer shows that the gases were discharged at over 280 deg. F.; however, their dew point was about 181 deg. F. and even had the dryer been longer, they could not, while in contact with 197 deg. material, have become so cold that condensation would occur.

The dryer designer may readily ascertain certain definite data concerning the material, such as its form and particle size, the initial and desired final moisture contents, maximum temperature allowable, density, specific heat, and required output. Frequently with this information in hand and a small sample of the material for inspection, he may calculate the size and type of machine best suited to the work to be done. It may happen, however, that the past experience he has relied upon to guide him in his calculations, is misleading. The material may seem quite similar to something with which he is perfectly familiar and the apparent difference so slight that modifications of design seen unnecessary, but the apparatus built will not function in the field as it did on the drafting board.

The length of time the material must remain in the dryer depends on the drying rate, which is governed partly by the amount of heat required to accomplish drying, and partly by

With the rotary steam tube dryer it is often possible to accomplish the drying while working at fairly low material temperatures

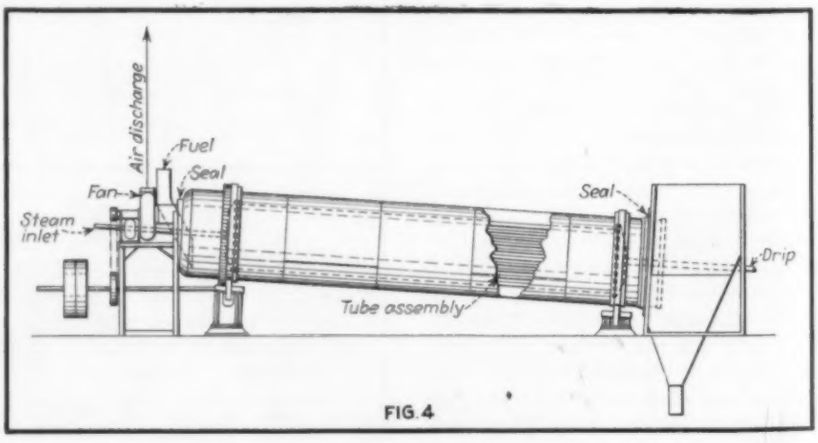
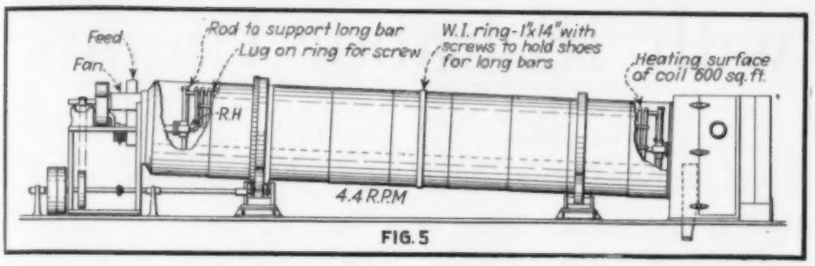


FIG. 4


Feed
Fan
Rod to support long bar
Lug on ring for screw
W.I. ring-1"x14" with screws to hold shoes for long bars
Heating surface of coil 600 sq. ft.
R.H
4.4 R.P.M
FIG. 5

A type of indirect heat dryer not so commonly used, in which a single steam tube spirals around the inside surface of the shell

the rate of heat transfer to the material. The quantity of heat required to overcome the hygroscopic attraction of the material, the heat transfer rate, the area exposed to the heating medium, and several other variables, cannot readily be predicated quantitatively by analysis. Their combined effect on drying can be accurately determined only by experiment. Therefore, an actual test on a quantity of material large enough to reveal reliable data is absolutely necessary if a really efficient dryer is to be designed. For this purpose, a test apparatus is invaluable.

As data are assembled through many tests on different materials, there may appear some constant factors not now in use that will prove of value and facilitate dryer design.

One type of dryer cannot be considered superior to all others. Each drying problem must be studied as a separate case. The goal to be attained by the designer is to dry the material properly at the lowest possible cost which does not necessarily mean the highest possible thermal efficiency as this might be obtained at an unreasonably high initial equipment cost.

COOLING TOWERS

(*Continued from page 211*)

N between the top and bottom wet-bulb temperatures (0.312 — 0.285 = 0.027) is then allocated uniformly at each section boundary and the average N (column 3) for each section used to calculate the vapor pressure increase in the section (column 4). These increases are added in each stage to the vapor pressure in the section below (column 5) and the corresponding air temperatures determined from psychrometric tables (column 6). Column (8) is the sum of columns (5) and (7). Column (10) is taken from tables for various values of t_c, and column (11) determined as the sum of columns (9) and (10).

If the rate of water cooling is assumed constant during the temperature drop Δt, the rate of cooling throughout the portion of the tower where Δt occurs equals 8.33 Q Δt. Equation (8) is then rewritten:

$$A = 8.33\,Q\,\Delta t / K\,(D_c - D_w) \qquad (9)$$

With $\Delta t = 1$ deg. F., $Q = 350$ g.p.m., and $K = 7.28$, $A = 8.33 \times 350/7.28\,(D_c - D_w) = 400/(D_c - D_w)$. Values of A for 82 deg. F. and 74 deg. F. are computed from the equation $A = 200/(D_c - D_w)$. The conditions at the temperatures listed are assumed constant from $(t_c + \Delta t/2)$ to $(t_c - \Delta t/2)$. The temperature conditions at the high and low points of the range act from 82 deg. F. to $(82 - \Delta t/2)$ deg., and from 74 deg. F. to $(74 + \Delta t/2)$ deg., respectively. These quantities are listed in column (13), the sum of which, S, is found to be 6,719 sq. ft. of effective perimeter area required for the slats.

Since the active tower area equals 140.8 sq. ft., and the effective perimeter area per cubic foot of tower is 8.83 sq. ft. as in Fig. 1, therefore, the required height of the filling is 6,719/(8.83 × 140.8) = 5.4 ft.

The net driving pressure causing cooling is $(D_c - D_w)$, where $D_w = p_a + Z_w t_a = p_w + Z_w t_w$. The pressure difference $(p_c - p_a)$ acts to produce evaporation. If all of the cooling were evaporative, the weight of water evaporated per pound of dry air (where 1,048 is the average latent heat) would be (82 — 74) × 0.935/1.048 = 0.00714 lb. of water. If $E = (p_c - p_a)/(D_c - D_w)$, E may be defined as the ratio which the evaporative cooling rate bears to the total cooling rate. The arithmetic average of the values of E at the start and finish of the cooling process may be used in estimating the water loss due to evaporation.

The temperature of the leaving air will be assumed as 72 deg. F., and the relative humidity will therefore be 91 per cent. Then, at the 82 deg. F. water temperature, $p_c - p_{ad} = 1.101 - (0.791 \times 0.91) = 0.381$ and $E_d = 0.381/0.487 = 0.783$. At the 74 deg. F. water temperature $p_c - p_{ae} = 0.846 - (0.737 \times 0.56) = 0.433$ and $E_e = 0.433/0.478 = 0.906$. Therefore, $E_{av} = 0.845$ and the weight of water evaporated per pound of dry air is 0.845 × 0.00714 = 0.00603 lb. Adding to this $H_{ae} = 0.00872$ lb. we arrive at $H_{ad} = 0.1475$ lb. The dew point of saturated air with a humidity of 0.0148 lb. is 68.8 deg. F.; the vapor pressure at that dew point is 0.709 in. *Hg*. The vapor pressure at 72 deg. F. is 0.791 in. *Hg*. Consequently, the relative humidity of the leaving air is 0.709/0.791 = 90 per cent. It would appear that the assumption of $t_{ad} = 72$ deg. F. was satisfactory.

Correction

In the first article of this series, which appeared in the February 1939 issue of *Chem. & Met.*, the editors wrongly interpreted the meaning of one of the symbols defined in the table of nomenclature on page 84. K was there defined as a complex coefficient, virtually a constant, whereas actually it should have been described as a complex coefficient considered constant for a given instantaneous rate of cooling. With change in the operating conditions as noted on page 85, K becomes a complex coefficient variable with the condition and velocity of the air, and other factors.

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5. A Theory of Cooling Towers, Compared with Results in Practice, by B. H. Coffey and George A. Horne, A.S.R.E. *Jour.*, 2, 6, pages 13, 14, 15.
6. "Applied Hydro- and Aeromechanics," by O. G. Tietjens, McGraw-Hill (1st ed.), pages 6 through 9 inclusive.
7. "Heating Ventilating Air Conditioning Guide," 1938, Vol. 16, pub. by A.S.H.V.E.: (7*a*) p. 2; (7*b*) p. 9.

Two Years with 18 Labor Unions

Here is the story of a company that operated on a liberal open shop personnel policy for 53 years and then succumbed to unionism. After two years of closed shop, both management and labor find their new relation harmonious and profitable.

R. H. SHAINWALD
Vice-President, Pabco,
The Paraffine Companies, Inc.
San Francisco, Calif.

WHEN CIO AND AFL agents stepped into the San Francisco offices of Pabco, The Paraffine Companies, Inc., that day in the spring of 1937 to discuss union recognition, the closing of the door behind them signified the end of a 53-year period in the company's history. The officials of Pabco believed the AFL and CIO representatives were wasting time, and told them so. The 1,500 employees of this pioneer company—makers of roofing, floor coverings, paints and other building supplies—had the advantages of a personnel policy so liberal it was a controversial subject among other employers.

There were, at least, a half dozen specific reasons why Pabco employees would not be interested in unionization—so the management thought. In the first place; Pabco paid its employees the highest wages in the industry. They were well above the scale paid by any competitor and the employees were aware of the fact. Also, Pabco's insurance program for employees was one of the most generous on record. Factory workers had been getting paid-up group insurance, with the entire cost borne by the company, since as far back as 1924.

Another advantage Pabco's personnel policy gave the factory employees was the annual vacation on full pay. The company was the first organization on the Pacific Coast to give mill and factory employees that benefit. The safety and well being of the employees came in for much careful attention. There was the company hospital and dentist's office maintained at the plant, in addition to the safety devices and rigid safety rules. Recreational and educational facilities were supplied by the company and their use was encouraged.

The employees even had a union of their own—The Employees Representation Council—for the expressed purpose of presenting the employee side of any and all matters pertaining to them and their work.

As the years rolled on, every concept that since has been called a "progressive labor policy" was added by the management and directors to the company's labor relations decalogue. We tried in every way to put the Golden Rule into effect. Yet, to what avail? For there, before us, stood representatives of 18 different unions demanding recognition.

"With all those advantages, is it conceivable that Pabco employees would *want* to unionize?" the union agents were asked.

"Ask your employees. Not us!" was the answer.

"All right! We'll do just that. We'll take a secret vote."

So the Pabco management did ask for a secret ballot among the employees, confident that the question of unionization would be settled once and for all time, by the men themselves.

It was. To the complete astonishment of Pabco officials, the voting revealed that some 55 per cent of the employees wanted outside unions.

It was galling to realize that the personnel program, once the pride of Pabco, had cracked under the first severe test, after 53 years of liberalism. Some hot tempers flared. Some one said the result of the voting was what might have been expected; the more you gave an employee, the more he wanted and the less grateful he was for what he had. Others said that humanitarianism to the men gave them the idea the company was soft and could be pushed. However, cold reason uncovered the fallacy of those ideas. By the same process the management came to the decision that the real cause probably lay in the fact that the company had been so busy marketing merchandise and building up the company that it had failed to sell the company to the employees.

As the first step in correcting that situation, it was decided that since the majority of the employees wanted to uninonize, the entire plant should be organized. It was thought that it would be inviting dissension and its reduced efficiency should some of the men be union members and some of them non-union.

During the few weeks immediately following the voting Pabco signed union contracts until 18 unions had locals represented in the company. About 65 per cent of the 1,500 employees affiliated with the AFL and the rest signed with the CIO. Thus, the first 53 years of Pabco's labor history were officially identified as a com-

pleted period and a new era was begun.

The task of selling the company to the employees was then undertaken and the first move in that direction was to transfer the personnel department from the manufacturing division to direct supervision by the president's office. The established personnel policy was re-examined and declared to be sound. Investigation showed that the probable cause of its failure was the confusion and misunderstandings which crept in as the policy rulings were passed down the line by word of mouth.

Consequently the personnel policy, with all of its subheads, was restated and reduced to writing in simple every day language in a booklet called "Pabco's Personnel Policies." Another pamphlet, "The 56-Point Personnel Program," described and explained the functions of the personnel and industrial relations departments to the men. The general attitude of the company was reflected in one paragraph of the program thusly: "They (the management) make every effort to establish harmonious relations with the employees. The machinery exists for employee committees, in addition to their union channels, to discuss any matters affecting employees."

With the 56-point program in writing, a person-to-person sales campaign was inaugurated and the superintendent, executives, department heads, foremen and key men of the plant were organized into classes. The beginning of a four-year educational program equivalent to a course in scientific management was under way. Labor relations and how to handle men were stressed. Parallel classes on union matters for union officials were inaugurated, too.

But the work of getting new procedure installed and in operation—of establishing the closed shop after more than a half century of open shop —of securing harmony between CIO and AFL affiliates—was an up-hill pull that had many anxious moments. All the troubles that plague and harass both employers and employees, from strike threats to work stoppages to boycotts were experienced. They were met, as they came up, as business problems and through applying the proper technique, agreements satisfactory to all sides were reached.

As Pabco management and employees became accustomed to the new working arrangements and old suspicions died out, a new spirit of trust and understanding began to creep through the entire organization. Confidence was developed by the constant exercise of tact and fair play by the company representatives. The interdependence of employer and employee was recognized and an "our company" attitude appeared. The men, aware that the security of their jobs rested upon the prosperity of the company, became unofficial salesmen with their eyes ever open for business prospects.

A typical case of this "new business scouting" was the truck driver who was making his regular route when he noticed that a competitor's product was being tested by the purchasing department of a neighboring community. He notified Pabco's sales department which swung into action and landed the order. Another case involved a man employed in the varnish factory. While off duty he uncovered a lead which resulted in the sale of roofing for a group of ten houses.

There are scores of similar cases which could be quoted to illustrate the new attitude among the employees of Pabco, but here's a particularly noteworthy example of the personal interest the men are taking in the affairs of the company. Its inception was during a meeting of shop stewards and union men. A union man said he was convinced that thousands of dollars were being wasted in the plant every year. His statements were specific and revealed that he had given a good deal of thought to the situation.

Right then and there he was appointed "waste engineer" and he began a new career his interest had created. He made a thorough study of the plant and by correcting such apparently minor losses as careless cutting to pattern size and of paint drippings on fresh floor coverings, he was able to effect savings that amount to thousands of dollars a year.

Another indication of the financial success of the new harmonious relationship between employer and employee may be seen in the fact that the fiscal year ended June 30, 1938, showed a sales volume amounting to 86 per cent of the preceding year. That was a drop of only 14 per cent —and during the sharp recession in the nation's business activity.

Employee efficiency and cooperation have risen steadily since unionization and undoubtedly the company's ability to maintain a high volume of business was due, in part, to the new understanding between the men and the management. It's an understanding that makes it possible for nicknames and given names to be customary between high ranking executives and rank and file factory hands, and makes the employee feel welcome to take his problems into the homes of company officials for discussion after business hours. That understanding has been promoted by every company executive and to a large extent by the "public opinion" research work of the reorganized personnel department. By frequent interviews and questionnaires, Pabco has tried to learn what its employees think and feel as individuals.

By such means it was discovered that the average employee believed he

A labor school for shop stewards was one result of unionization at Pabco

had not enough information about the functioning of the company nor about the company's products. To fill that need a contest was devised which was built around a set of facts especially gathered and prepared for publication in an employees' manual called, "The Pabco Book of Knowledge." This material was issued in loose-leaf form to each employee and every week a new page was distributed. Some feature of the company, or its products, was illustrated with carefully selected photographs or drawings and the pertinent facts were told simply in a paragraph or two of text.

As an example of the type of material issued, one of the pages was devoted to Thermislab roofing—its method of manufacture, uses and advantages. Another example was the page given over to "pie" charts which explained where the Pabco dollar goes. Employees had a deep-seated notion that executives and stockholders got a tremendous slice out of the Pabco dollar and that a tiny remainder went to the employees. They were amazed to learn that 48½ cents of the Pabco dollar is used to buy raw materials; 25 cents is paid to employees in wages and salaries; 15½ cents goes for various operating expenses; 4½ cents is paid to stockholders and 3½ cents is taken by taxes.

In order to promote a personal interest on the part of the employee in the story of Pabco, as explained in the "The Book of Knowledge," a set of four questions is issued as a companion piece for each page. The questions are concerned with the subject explained and may be answered by checking "True" or "False." A fifth question asks for a short essay about the subject in not more than twenty-five words. Each employee, or a member of his family, is eligible to receive one of the 210 prizes offered. Employees are given attractively bound copies of the complete book for their homes where it is welcomed as an addition to the family library.

The contest was planned to spread the story of Pabco among its employees, but there were at least two totally unexpected reactions. One of the surprise responses was the flood of orders for copies of the contest material which came in from all parts of the United States. Universities and schools, libraries and research institutions, labor leaders and manufacturers of everything from airplanes and automobiles to raw steel sent in requests for copies.

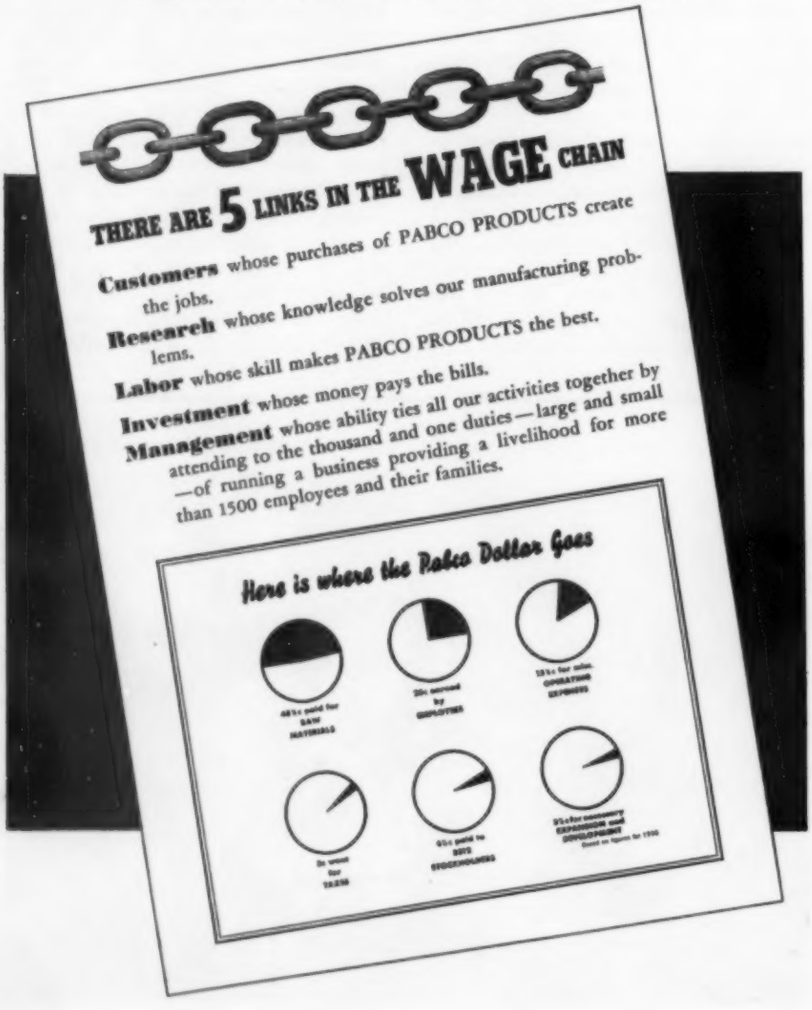
The second surprise was the voluntary sales assistance given by the unions and by union members individually. In one instance, a recommendation from a union delegation was instrumental in closing the sale for Pabco floor covering to be used in a public building. In a similar way, Pabco linoleum was selected for a new school being erected in a nearby town. Political subdivisions use a lot of paint on their highways and linoleum and roofing products for public buildings. The unions have formed voluntary committees to obtain such business for Pabco.

Another case of voluntary assistance from a union was when one of them used its own letterhead in writing to merchants to remind them of Pabco's local annual payroll of $3,000,000 and to recommend full consideration of the company's products.

Pabco's second half century seems to be well launched, for it accomplished the transition from open shop to closed shop without strikes or one minute lost due to stoppage of work. It is one of the few organizations where CIO and AFL members work side by side with good will and understanding. Labor efficiency in its plant is the highest Pabco ever has had—and the wages are the highest Pabco ever has paid.

When, in 1937, Pabco made the difficult decision to relinquish its paternal attitude towards its employees and to place the full responsibility for labor efficiency squarely upon the shoulders of the petitioning unions, the management was skeptical of the outcome. Subsequent events, however, have proved that labor relations, based upon full understanding of employer-employee problems, can be harmonious and profitable to management and labor alike.

A page from the "Pabco Book of Knowledge," a manual of information about the company written for the edification of its employees


THERE ARE 5 LINKS IN THE WAGE CHAIN
Customers whose purchases of PABCO PRODUCTS create the jobs.
Research whose knowledge solves our manufacturing problems.
Labor whose skill makes PABCO PRODUCTS the best.
Investment whose money pays the bills.
Management whose ability ties all our activities together by attending to the thousand and one duties—large and small—of running a business providing a livelihood for more than 1500 employees and their families.
Here is where the Pabco Dollar Goes

Synthetic Phenol Processes

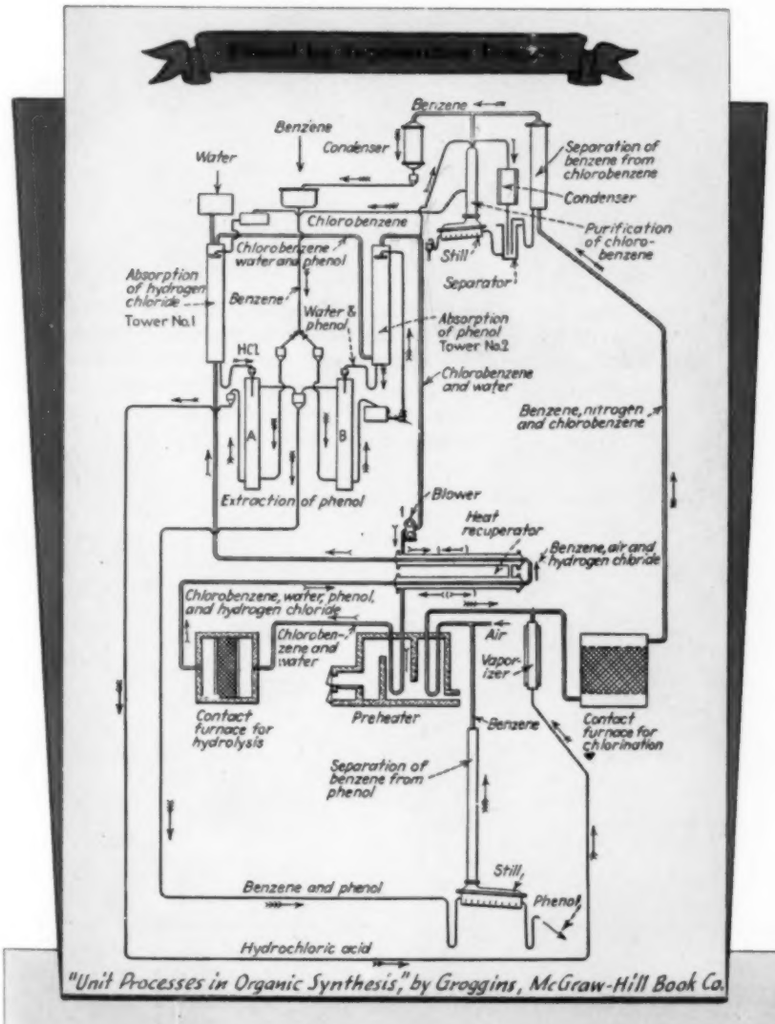
SEVERAL METHODS are in use for producing phenol synthetically. The benzene-sulphonate and monochlorobenzene processes have been in operation for some time, and a plant for the regenerative or Raschig process will shortly be completed.

The process which dominated the industry in the early days and is employed at the present time by the Monsanto Chemical Co. makes phenol by sulphonating benzene, neutralizing the resulting benzene sulphonic acid, and fusing the sodium benzene sulphonate with caustic soda.

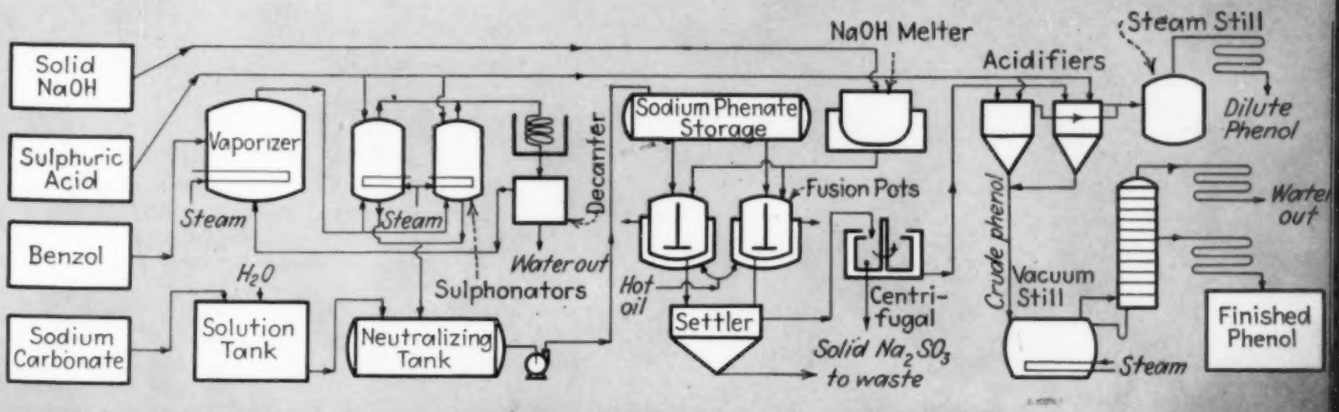
The regenerative process is controlled in the United States by the General Plastics, Tonawanda, N. Y. According to "Unit Operations in Organic Synthesis" by P. H. Groggins, this method is based on a combination of two processes: (1) The production of chlorobenzene from benzene and hydrogen chloride and air, and (2) The hydrolysis of chlorobenzene with water vapor in the presence of a catalyst.

In a third process the Dow Chemical Co., Midland, Mich., produces phenol from chlorobenzene. The monochlorobenzene and caustic soda are compressed by powerful pumps to pressures approximating 5,000 lb. per sq. in. The chemical reaction, under high pressure, occurs in furnaces, each of which contains a mile of pipe. Once started, the reaction generates its own heat. The products of the reaction pass to a battery of stills where the phenol is purified until it attains a congealing point exceeding 40 degrees C.

Diagrammatic flow sheets of the first two processes discussed appear on this page, while both diagrammatic and pictured flow sheets of the process used by Dow are shown on pages 222 and 223. Data on plenol are on page 224.



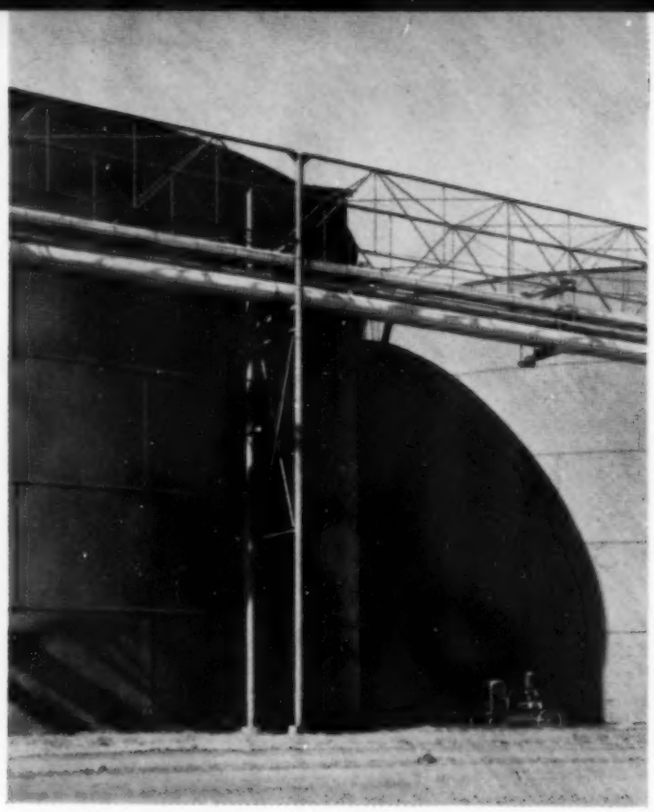
"Unit Processes in Organic Synthesis," by Groggins, McGraw-Hill Book Co.



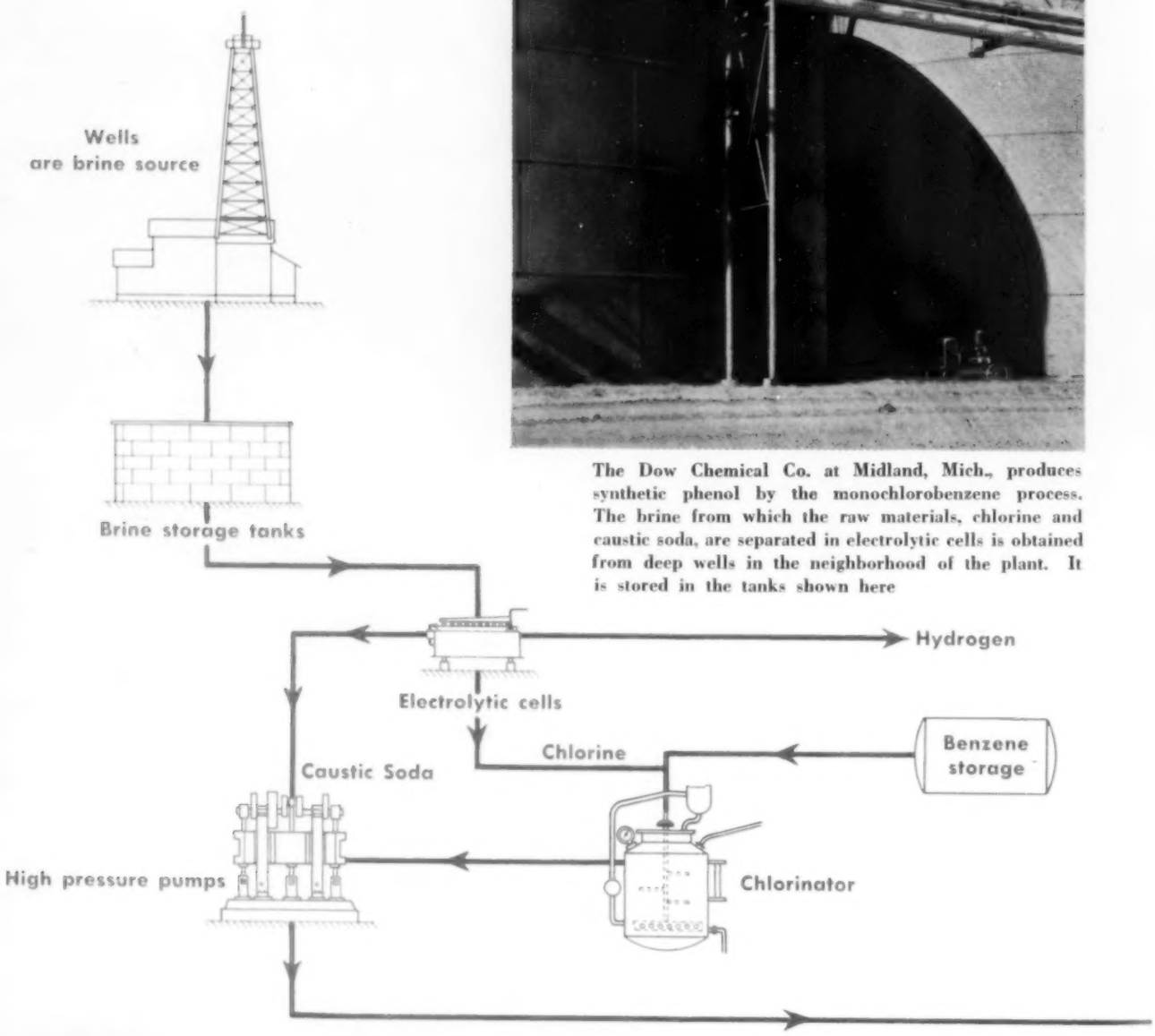
Benzol (Pure)	2,000 lb.	Steam	4000 lb.	Per ton of Phenol
Sulphuric acid (66° Bé.)	4,000 lb.	Electricity	800 kw.-hr.	
Caustic soda (76%)	2,600 lb.	Direct Labor	70 man-hr.	

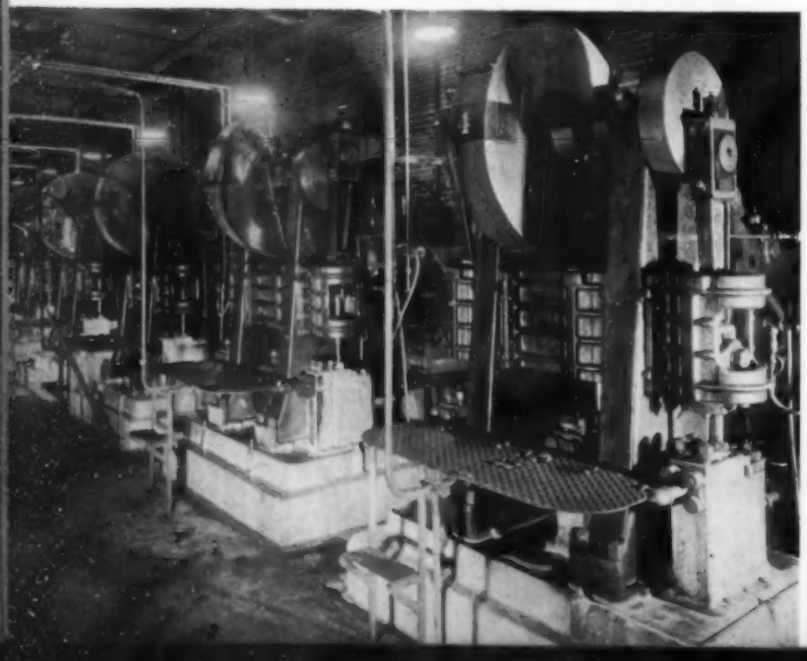
Chem & Met's generalized flow sheet and materials estimate, May, 1934, Supplement

Phenol From Monochlorobenzene



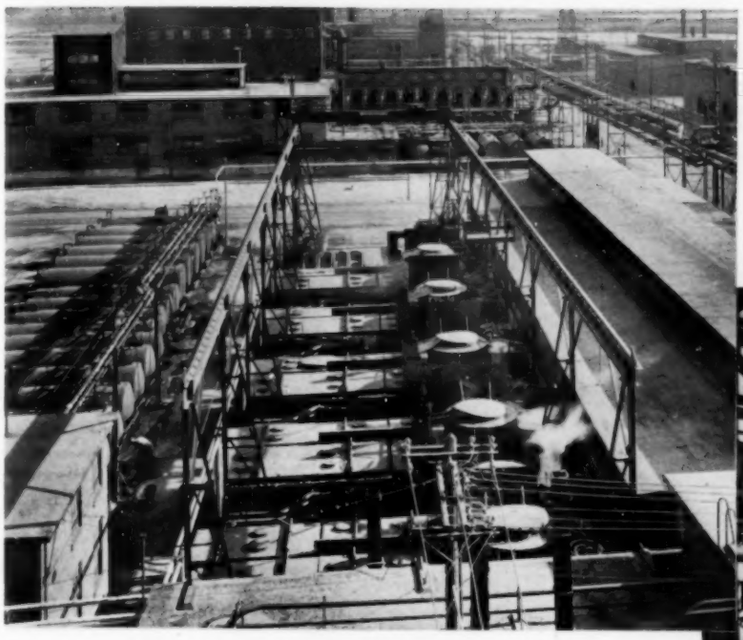
The Dow Chemical Co. at Midland, Mich., produces synthetic phenol by the monochlorobenzene process. The brine from which the raw materials, chlorine and caustic soda, are separated in electrolytic cells is obtained from deep wells in the neighborhood of the plant. It is stored in the tanks shown here



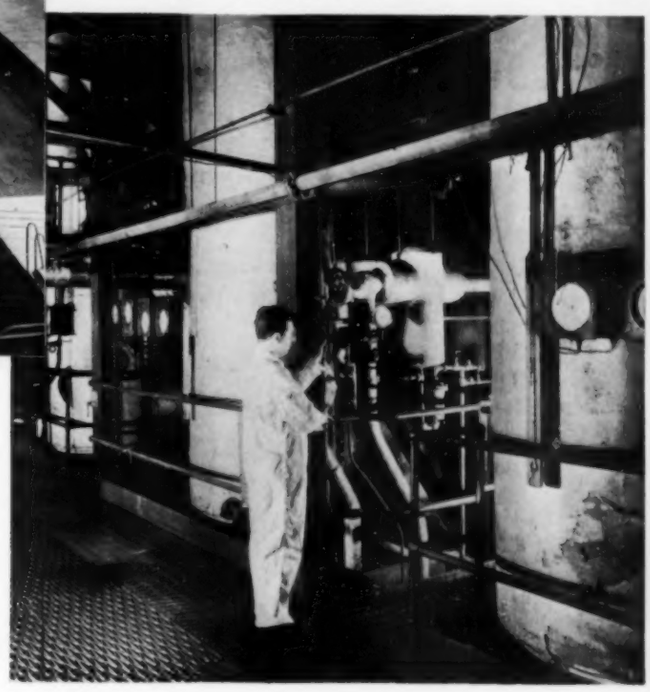


Chlorinated benzene and caustic soda are subjected to pressures approximating 5,000 lb. per sq. in. by powerful pumps preparatory to passing into the furnaces. Some of these pumps installed in the Dow plant are shown on the left

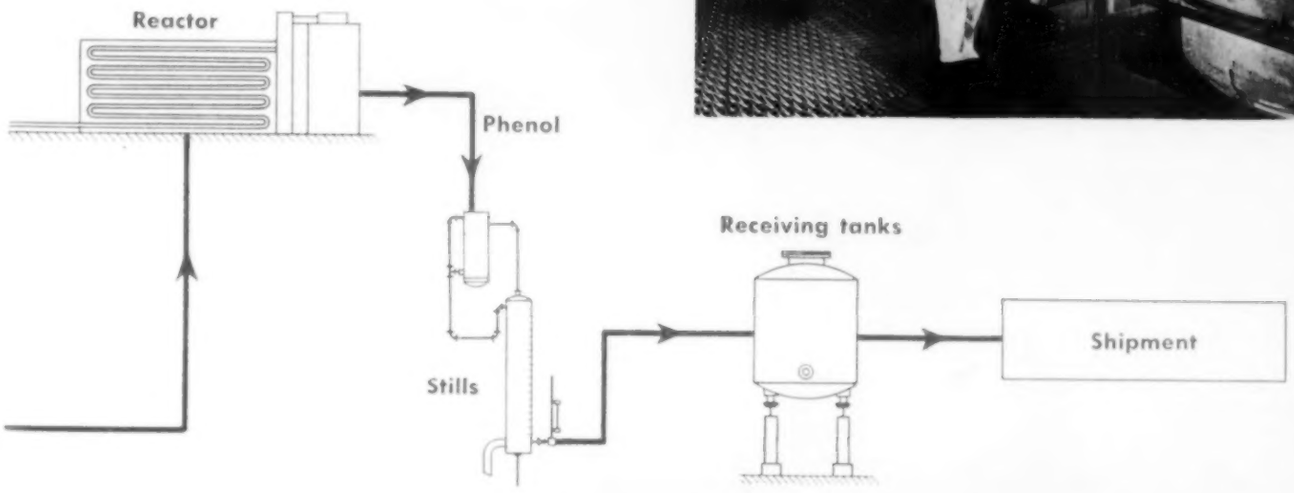
A Chem & Met PICTURED FLOW SHEET



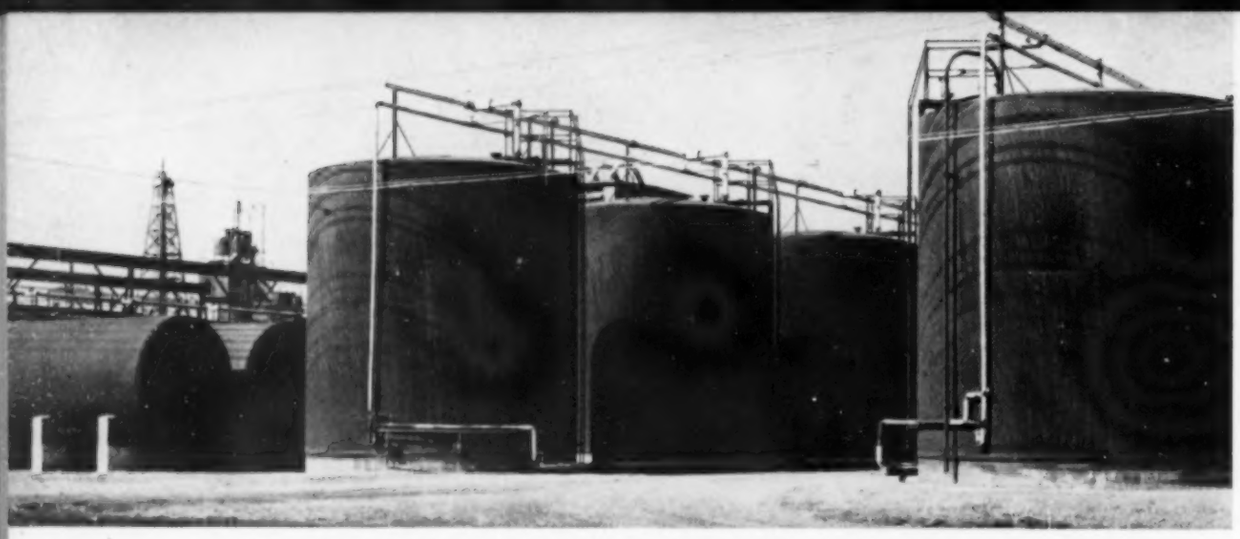
Products of the reaction between monochlorobenzene and caustic are separated in this battery of stills. The purified phenol attains a congealing point exceeding 40 deg. C.



Hydrolysis takes place in the furnaces illustrated above. Each contains a mile of piping. The chemical reaction, under high pressure, once started generates its own heat



Since most applications for phenol call for high purity and good color the finished product is stored in glass-lined receiving tanks prior to shipment



Battery of tanks for the storage of phenol at the Midland, Mich., plant of the Dow Chemical Co.

Phenol Production

PROPERTIES: Colorless, interlaced, or separate, needle-shaped crystals which melt to a clear, colorless liquid. It has a characteristic, somewhat aromatic odor. When undiluted it cauterizes and whitens the skin and mucous membrane.

Specific gravity at 41-4 deg. C.	1.058
Pounds per gallon at 41 deg. C.	8.83
Boiling point	181.6 deg. C.
Congealing point	40.7 deg. C.

SOLUBILITY, grams per 100 grams solvent:

Alcohol at 25 deg. C.	∞
Carbon Tetrachloride at 25 deg. C.	∞
Ether at 25 deg. C.	∞
Water at 25 deg. C.	9.5
Water at 80 deg. C.	∞

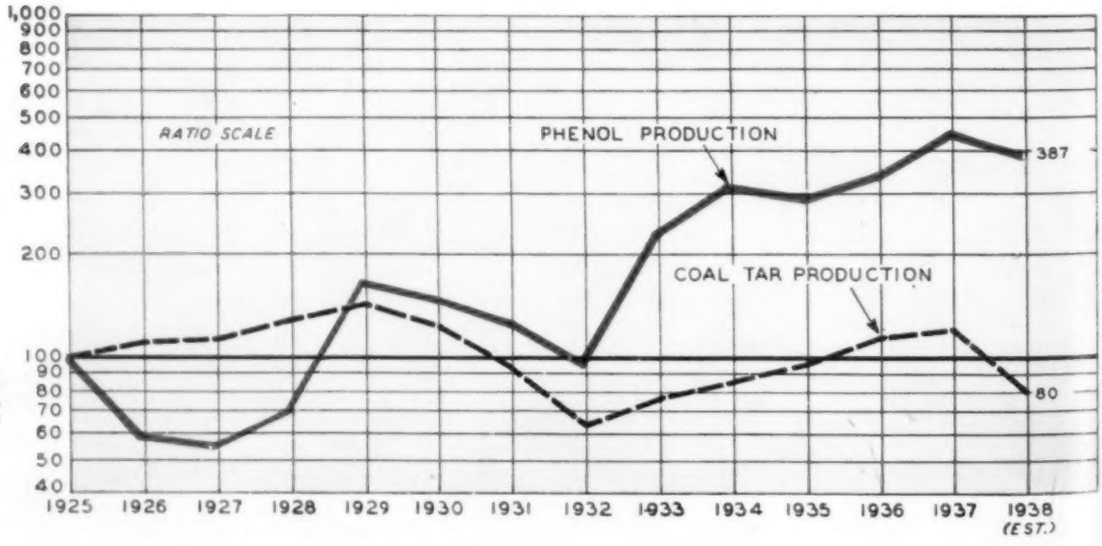
SPECIFICATIONS: Congealing point, not less than 40.0 deg. C.

USES: Phenol is used in the manufacture of synthetic resins and plastics, picric acid and other explosives, salicylic acid, acetphenetidin, dye intermediates, artificial tannin, rubber, photographic chemicals, synthetic perfumes, and as a developing agent in the dyeing and printing of textiles. It is used as a standard in testing disinfectants and its germicidal action is utilized in many ways, for example, in the manufacture of germicidal and disinfecting paints and germicidal soaps, and as a preservative in the leather, glue and adhesives industries. Its use as a selective solvent in the refining of low-grade distillates has greatly increased the number of types of distillates which can be profitably used to produce high quality lubricating oils.

SHIPPING CLASSIFICATION: Specifically provided for in railway freight classifications.

	Lb. Net	Lb. Gross
PACKING: Tank cars, steel: 10,000 gal.	85,000[1]	
Tank cars, steel: 8,000 gal.	67,000[1]	
Drums, galvanized: 55 gal.	475	587
Drums, galv.—s.t.c.: 25 gal.	200	216
Tins, crated: 29 gal.	250	295

[1] Approximate.



Phenol and coal tar production. Index numbers, 1925 = 100. Source National Industrial Conference Board

36 YEARS IN THE GAS HOUSE!

Dramatic 36 Year Performance Record of 25 Allis-Chalmers Motors Told by R. B. Brown, President, Milwaukee Gas Light Company! Find Out How Lo-Maintenance Motors with Full Measure Construction Can Save Money for You!

Another true case history from the Allis-Chalmers files that proves **"IT PAYS TO BUY THE EQUIPMENT THAT PAYS FOR ITSELF!"**

FIGHTING SOME OF THE WORST POSSIBLE CONDITIONS any motors could meet — that's what 25 Allis-Chalmers Lo-Maintenance Motors, like the one pictured above, had to do for 36 years without running up costly repair bills!

Fighting steam and hot coke . . . rain and snow . . . surrounded by some of the worst operating conditions any motor could face — that's what 25 Allis-Chalmers Lo-Maintenance Motors had to meet and beat . . . for 36 years . . . and do it with a minimum of maintenance!

And when R. B. Brown, president, Milwaukee Gas Light Co., tells a sensational performance story like that . . . we give it to you — in his own words — just as he gave it to us in his unsolicited letter of Nov. 29, 1938.

Chooses Allis-Chalmers!

"When our West Side Works was built in 1902," said Mr. Brown "it was the first gas works to be entirely equipped with motors. And those motors were Allis-Chalmers. Steam and hot gases from quenched coke surrounded the motors. Some were installed in wet coal breaker pits . . . in outdoor locations swept by rain and snow. You couldn't have hand-picked a set of worse conditions in which to test motors!

"Last year we shut down this plant. And here's what we found! Those 25 Allis-Chalmers Motors were still going strong! And to top it off, we have had hardly any maintenance expense . . . and not one motor had to be replaced!

"Now I don't know of any other motors that have had such life. And when you add that this plant has operated 24 hours a day, 365 days a year for 36 years — that in itself adds very materially to the job these Allis-Chalmers motors have done!"

It's records like these that prove you get more than just a rated horsepower when you install Allis-Chalmers Lo-Maintenance Motors. And it's records like these that are making men, responsible for production in their plants, switch to Allis-Chalmers!

They know about the high carbon steel frame, indestructible rotor and distortionless stator . . . husky Full-Measure construction with no skimping on materials — that's a combination that knocks their repair bills to a real low!

Get the whole story of how Allis-Chalmers 90 years of advancing with industry works for you when you install a Lo-Maintenance Motor. Call the nearest district office or write direct to Allis-Chalmers. That's the way to get started on cutting your maintenance costs . . . keeping your production steady!

1079

MOTORS FOR ALL APPLICATIONS FROM ½ HORSEPOWER AND UP

ELECTRICAL DIVISION

ALLIS-CHALMERS

MILWAUKEE·WISCONSIN

HOW TO PICK THE RIGHT GATE OR GLOBE VALVE FOR A SPECIFIC SERVICE

THERE is no such thing as any one valve to meet *every* service. The very feature, for instance, that makes a ball type disc valve ideal for hot oil lines, makes it unsuitable for throttling. And when a valve leaks, it doesn't necessarily mean that only the seat is at fault—that valve may be the wrong type for the service on which it is used.

In almost any service there is one valve that will perform better than any other. That is why the Crane Catalog lists thousands of valves—to assure your getting the one that exactly fits your requirements. The problem, then, is how to pick the right one. As a matter of fact you, who know the actual conditions of your service, are in a better position than anyone else to select the valve you should use.

GET THIS VALUABLE GUIDE FREE

To assist you in making this selection we have prepared a bulletin, "Service Characteristics of Globe Valves and Gate Valves," containing a useful chart designed to help you work out your requirements. It greatly simplifies your selection by showing the service characteristics of each type of valve. A copy of this valuable bulletin will be sent to anyone interested—mail the coupon.

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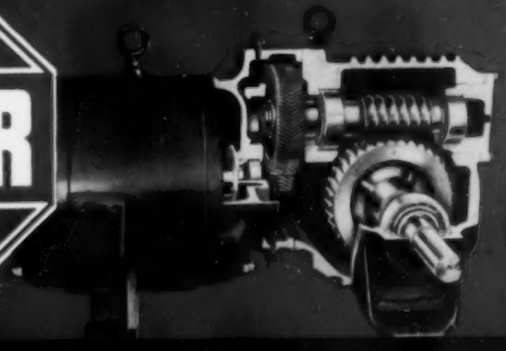

METERED PROPORTIONS
WITH MORSE VARIABLE SPEED CONTROL

GET IT RIGHT EVERY TIME
WITH THIS COMPACT, SIMPLE UNIT

Get it right every time! Hit proportions "on the nose" for mix after mix with the simple mechanism of the Morse Variable Speed Control.

Morse Variable Speed Control regulates rate of flow of materials and mixtures simply, easily, accurately. Settings may be made through infinite variations from 4½ to 1 to 120 to 1—made with great accuracy with the hand wheel control and visible dial. The unit's output speed may be changed at *any time*, as often as required—its accuracy and dependability doesn't change!

The compact, clean design of the Morse Variable Speed Control makes it easily adaptable to various types of feeders and dry material handling equipment. Special hardened steels are used in cams, gears, and bearings. It is so engineered that there isn't a single part inside the case which can become loose and troublesome.

Morse Variable Speed Controls are controlling speeds and proportions in leading plants throughout the country today. Let us tell you about users' experiences in efficient, economical operation with these units. Just ask the nearest Morse representative, or write direct to Morse, Ithaca.

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Computing Mixed Acids Graphically

In most cases where it is possible to handle routine plant calculations by graphical methods, quicker and much more accurate results are obtained. Dr. Berl has developed a graphical means for calculation of mixtures such as mixed nitric and sulphuric acids.

ERNST BERL

Research Professor
Carnegie Institute of Technology
Pittsburgh, Pa.

IN THE FOLLOWING a method is described for using the Gibbs trilinear system of coordinates for the graphical solution of plant mixing problems, where three components such as nitric acid, sulphuric acid and water must be present in certain desired proportions in the finished product. Any of the materials entering into the mixture may themselves contain varying proportions of the several components. For example, in preparing mixed acid, the nitric acid will also contain water, and the sulphuric acid may contain water. In reviving a spent mixed acid containing nitric and sulphuric acids and water, nitric acid containing water, and oleum, will be used in producing the desired finished material.

Graphical methods are much superior to the use of the rather complicated formulas which are ordinarily used for such calculations. (See Berl-Lunge, Chemisch-techniche Untersuchungsmethoden, 8th ed., vol. 2, p. 674.) In addition to requiring considerable time for their arithmetical calculation, formulas are often a cause of error. Graphical devices such as those described here, however, are grasped without difficulty by the non-technical operator. Especially if he is provided with charts of sufficient size, errors are unlikely.

In the general case of the use of the Gibbs chart for three components, A, B and C, which are to be mixed to form a mixture, D (the composition of which lies within the triangle ABC), two methods may be used:

Ratio Method—Referring to Fig. 1, it will be noted that the three ingredients having compositions of A, B and C are themselves mixtures of the three pure components X, Y and Z in varying proportions. They are to be mixed to produce a mixture, D. Any of the several ingredients could, of course, consist of one or two of the pure components, instead of three.

To determine the required proportions, one draws through D the lines ADA′, BDB′ and CDC′ which intersect BC at A′, AC at B′ and AB at C′. Then, the required amount of A must correspond to the ratio DA′/AA′; the amount of B to the ratio DB′/BB′; and the amount of C to the ratio DC′/CC′. This method does, however, require calculation of the ratios. The completely graphical method described below may be preferable.

Graphical Method—For a completely graphical solution of the problem of Fig. 1, draw lines from point D parallel to AC and BC. These parallels cut the line AB at points E and F. Then AE corresponds to the amount of B required, EF to the amount of C, and FB to the amount of A. To apply these proportions to a definite amount of the finished mixture, such as 50 tons, draw the line AG representing 50 units, and from E to H and F to I draw parallels to BG. Then the length AH represents the number of

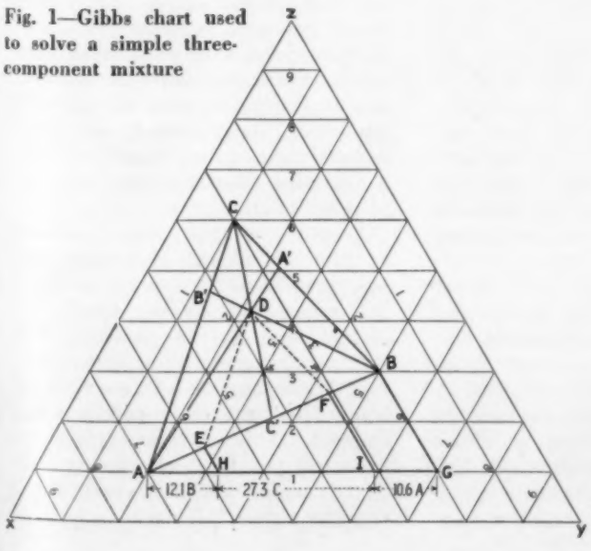


Fig. 1—Gibbs chart used to solve a simple three-component mixture

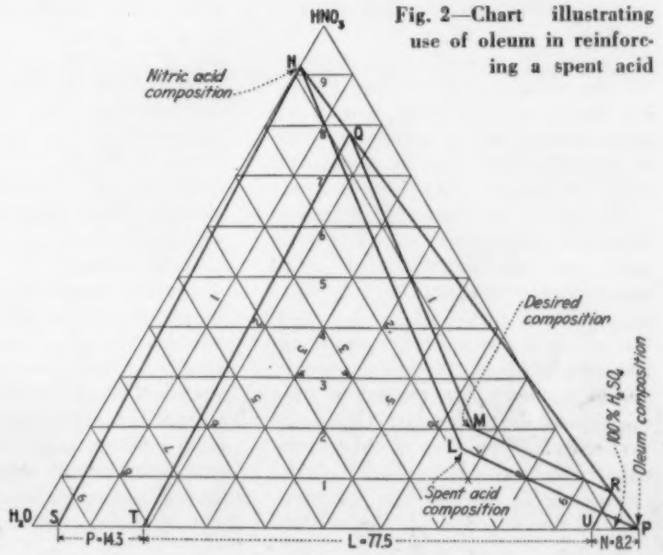


Fig. 2—Chart illustrating use of oleum in reinforcing a spent acid

tons of B, the length HI the number of tons of C, and the length IG the number of tons of A that must be mixed to produce 50 tons of D.

Calculating Oleum Additions

If oleum has to be used to reinforce a spent acid, the line of the chart representing H_2O—H_2SO_4 has to be extended as in Fig. 2. This is for the reason that oleum is more than 100 per cent H_2SO_4 (i.e., water must be added to it to bring it to 100 per cent H_2SO_4 strength). For example, a 20 per cent oleum corresponds to 104.5 per cent H_2SO_4; a 25 per cent oleum to 105.6 per cent H_2SO_4; a 60 per cent oleum to 113.5 per cent H_2SO_4; and a 100 per cent oleum to 122.5 per cent H_2SO_4. (For other oleum percentages see Dr. Berl's Nomographic Chart II, p. 174, March 1939, *Chem. & Met.*—Ed.)

As in Fig. 2, if a spent acid of the composition L (containing 66 per cent H_2SO_4, 16 per cent HNO_3 and 18 per cent H_2O) has to be reinforced with 20 per cent oleum and 92 per cent HNO_3 to the composition M (containing 66 per cent H_2SO_4, 20 per cent HNO_3 and 14 per cent H_2O), a triangle is made connecting L with N and P. N represents the concentration of nitric acid and P, the strength of oleum expressed in per cent H_2SO_4. One draws a line from M to Q, parallel to LN, which cuts the line NP at Q. Another line parallel to LP from M cuts the line NP at R. Then NQ represents the amount of oleum P, QR the amount of spent acid L, and RP the amount of nitric acid N which must be mixed. To mix a certain quantity, for instance 100 tons, one puts 100 units on the line PS and draws parallels to line NS from Q to T and from R to U. Then ST represents the amount of oleum P, TU the amount of spent acid L, and UP the amount of nitric acid N, all expressed in tons which have to be mixed to get 100 tons of mixed acid with the composition M.

The chief constituents of mixed acids are sulphuric acid, nitric acid, and water. In addition most spent mixed acids contain organic substances and nitrosylsulphuric acid. These last mentioned substances can be considered as foreign materials, provided the water content of the mixed acid is rather low (below 20 per cent). Then they do not influence considerably the results of the nitration. To correct the composition of the mixed acid, the analytically found amount of N_2O_3 expressed in per cent has to be expressed as SO_5NH. For each 1 per cent of N_2O_3, 2.58 per cent H_2SO_4 has to be subtracted from the H_2SO_4 content and 0.24 per cent H_2O has to be added to the water content. One per cent N_2O_3 corresponds to 3.34 per cent SO_5NH.

Organic substances and SO_5NH, calculated as mentioned, have to be subtracted from 100. The sum of the remaining amounts of H_2SO_4, HNO_3 and H_2O, representing the true composition of the mixed acid, is then considered as 100. The values obtained in this way may then be inserted in the Gibbs triangle.

For example, the analysis of a waste mixed acid gave 60 per cent H_2SO_4, 20.0 per cent HNO_3, 18 per cent H_2O, 1 per cent N_2O_3 and 1 per cent organic substances. The result therefore is: 60 — 2.58 = 57.42 per cent H_2SO_4; 20 per cent HNO_3; 18.0 + 0.24 = 18.24 per cent H_2O; 3.34 per cent SO_5NH; and 1 per cent organic substances. The sum of the acid and water percentages is 57.42 + 20.0 + 18.24 = 95.66 and the mixed acid composition (less SO_5NH and organic materials) is 100 × 57.42/95.66 = 60.02 per cent H_2SO_4; 100 × 20.0/95.66 = 20.91 per cent HNO_3; and 100 × 18.24/95.66 = 19.07 per cent H_2O.

New Distilled Water System

The Mallinckrodt installation is of particular interest since it represents the first large-scale scheme of an all-aluminum storage and distribution system for distilled water

H. V. CHURCHILL

Chief Chemist
Aluminum Research Laboratories
Aluminum Company of America
New Kensington, Pa.

AN ALUMINUM WATER SYSTEM recently installed by the Mallinckrodt Chemical Works is of particular interest, not only because of its large capacity but also because of certain unusual design features. Among the products of this company are pharmaceutical, laboratory, and photographic chemicals. Many of these are of high purity. Such standards of purity can be attained only by strict control of impurities in all of the materials used in manufacture. The most widely used of these materials is water. To avoid contamination by the impurities present in its natural water supply, Mallinckrodt uses distilled water in processing many of their products.

A need recently arose for a larger supply of distilled water. It was also felt that the new system should also provide, if possible, water of better quality than heretofore available. A comparison of the water from an old plant system and from a newer aluminum storage system which had been in service for some time, revealed certain superiorities in the water from the latter system which could only be attributed to the material from which it was constructed. For this reason, aluminum was specified for the storage tanks and distribution lines of the new system.

The distilled water used is made by distillation in a triple-effect still of standard design from city water which has been subjected to a preliminary process of purification. The resultant distilled water is, in addition to being free from the ordinary impurities, also extremely free from ammonia and carbon dioxide and has a pH value closely approaching that of pure water.

From the still the water is pumped to four cylindrical aluminum storage tanks having a capacity of 2,000 gal. each. These tanks, located on ground level, are so connected that they can be operated in batteries of two. While one set of two tanks is being filled, the other pair is being emptied. This arrangement permits a control test to check against accidental contamination of each batch of water before it is used.

In a penthouse on the roof of a nearby building is a 2,000 gal. distribution tank, from which the water flows by gravity to various points in this building and in adjacent buildings where it is used. Part of the line through which water is pumped from the storage to the distribution tank is underground, and special precautions have been taken to protect the outside of this pipe from soil corrosion. Several rectangular loops have been included in this line to provide for expansion.

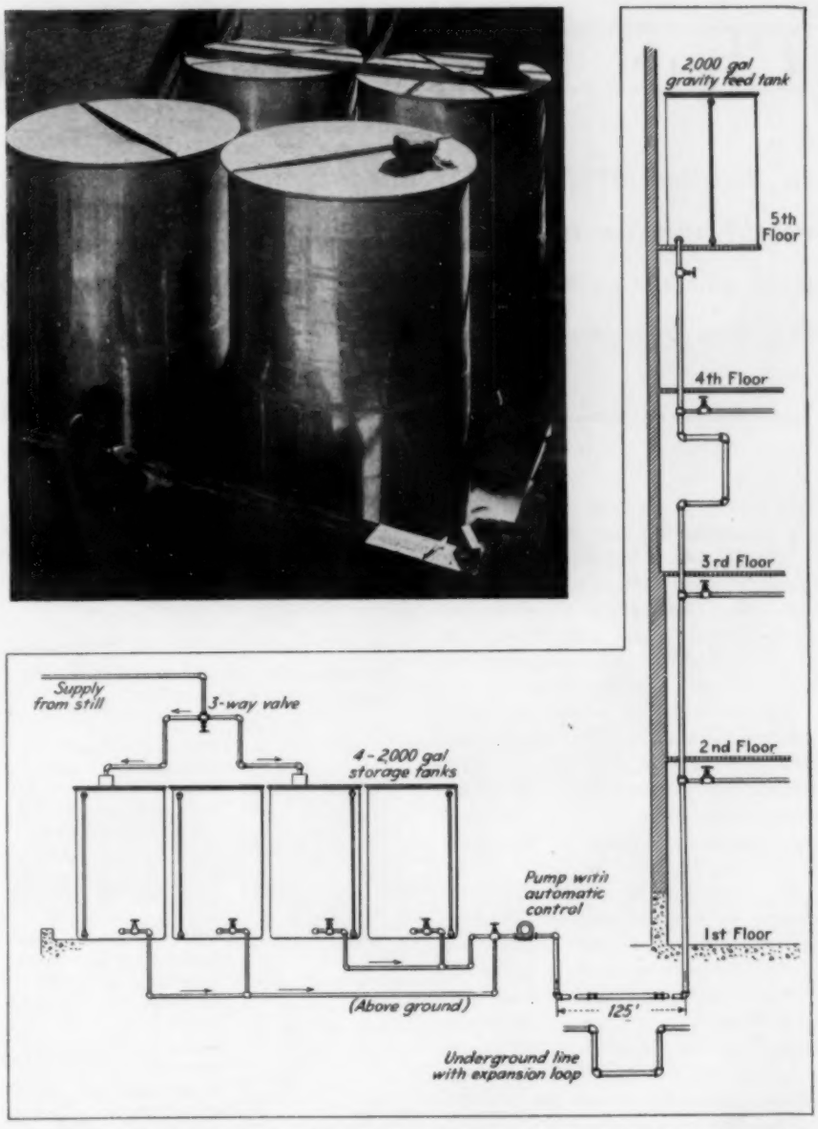
An automatically controlled pump transfers water from the storage to the distribution tank, in which a constant level is maintained. This feature not only assures an uninterrupted supply of water, but a constant pressure at the plant outlet. The storage tanks are welded from 3S plate. The covers, which are loose, are in two sections. The inlet pipe is so arranged that there is no electrical contact between the feed line and the tank. Suitable provisions for sampling and draining are made. The line from the storage tanks to the distribution tanks is 3 in. I.P.S. of 3S alloy. The distribution lines are of smaller sizes as determined by the needs at various points. The pump and valves are bronze.

The increasing use of aluminum in distilled water storage and distribution systems is primarily based upon the fact that it does not contaminate distilled water with which it is in contact. The low content of dissolved solids in properly made distilled water, stored and conveyed in aluminum, has been established so that the main technical problem remaining is that of the assembly of aluminum distilled water systems.

Designs of aluminum storage and distribution systems are similar to those used for other materials of construction. The tanks are usually constructed of 3S alloy, which is an alloy of aluminum with about 1.25 per cent manganese added. This alloy is substantially as inert to distilled water as pure aluminum, and has the advantages over the pure metal of being stronger and harder. It can be readily formed and welded.

Size and shapes of tanks are determined by installation requirements. Heating coils, or jacketing for heating, can be provided, as well as sight glasses and other accessories. Covers are usually fitted loosely, but are so designed as to prevent contamination of the tank contents by atmospheric dusts. It is desirable to have the discharge from the still fall a short distance through air before entering the tank, in order to aerate the water. Aeration of distilled water minimizes the reaction between distilled water and aluminum. This method of discharging water from the still also permits the elimination of any metallic electric contact between the still and the distribution system. When tanks are to be set on a concrete base, the tank bottoms should be coated with bituminous paint before installation.

The piping used in distilled water lines from the 3S aluminum tanks is also preferably of the same composition. Such aluminum tubing is available in standard iron pipe sizes. Aluminum pipe fittings are made in an aluminum alloy designated in the trade as B214, which contains about 3.75 per cent magnesium and 1.75 per cent silicon. All joints are made with a standard, tapered pipe thread. Aluminum pipe is handled in the average pipe shop or in the field in about the same manner as iron pipe. The characteristics of aluminum, however, differ somewhat from those of the other commonly used materials; these characteristics should be understood in order to obtain the best results.



Plan of Mallinckrodt aluminum distilled water system. The four 2,000-gal. storage tanks are shown above. The system is of interest because of its large capacity and unusual design features

Chart for Equilibrium Calculations

In distillation and other unit operations involving vaporization and condensation, equilibrium calculations are frequently required. Usually the problem is solved by trial and error, a rather lengthy procedure. The author, however, reduces the working time to a few minutes with a simple chart.

WILLIAM S. POPE*
Chemical Engineer
New York, N. Y.

VARIOUS FORMULAS available in handbooks and textbooks for distillation equilibrium calculations are rather tedious to use. Some of the larger companies have devised methods that enable routine workers to make the necessary computations with a greater degree of speed.

The necessity for a trial and error solution is perhaps the most undesirable feature of equilibrium calculations. The approach is especially slow if the engineer does not know the approximate range in which the results should fall.

It is possible to plot curves that should enable the average engineer to reach a satisfactory solution in about fifteen minutes. This graphical method has three definite advantages: (1) reduces the number of necessary trials, (2) simplifies the mathematical solution, and (3) by offering a visual guide reduces the possibility of arithmetic errors.

This scheme is normally limited in its application to continuous equilibrium vaporization or condensation. It may be used in connection with problems involving two or more miscible components that follow Raoult's law. Any two components of the total fluid must fall into Class I, i.e., mixtures having vapor pressures intermediate between those of the pure components.

Since mixtures of this class can be more or less completely separated into their fractions by distillation, it follows that the most important use of this method will have to do with distillation. It is applicable to the calculations required in the design of stills, reboilers, columns and condensers.

Each individual calculation has as its objective the determination of the percentage vaporized at a given temperature, and the composition of the vapor and residual liquid. Derivations of necessary formulas are given below:

Let X'_A, X'_B, X'_C = Mol fractions of components A, B and C, respectively, in original fluid before vaporization or condensation.

X_A, X_B, X_C = Mol fractions components A, B and C, respectively, in residual liquid.

Y_A, Y_B, Y_C = Mol fractions components A, B and C, respectively, in vapor in contact with residual liquid.

p_A, p_B, p_C = Vapor pressures of components A, B and C, respectively, at given temperature.

P = Total pressure.

V = Total mols vaporized per 100 mols original fluid.

L = Total mols of residual liquid per 100 mols original fluid.

$$L + V = 100 \qquad (1)$$

Resultant material balance equations:

$$X_A L + Y_A V = 100\ X'_A \qquad (2)$$

$$X_B L + Y_B V = 100\ X'_B \qquad (3)$$

$$X_C L + Y_C V = 100\ X'_C \qquad (4)$$

In accordance with Dalton's and Raoult's laws:

$$Y_A = \frac{p_A\ X_A}{P} \qquad (5)$$

$$Y_B = \frac{p_B\ X_B}{P} \qquad (6)$$

$$Y_C = \frac{p_C\ X_C}{P} \qquad (7)$$

The sum of the X-values of the residual liquid must equal unity:

$$X_A + X_B + X_C = 1 \qquad (8)$$

The temperature and total pressure are fixed, and vapor pressures of individual constituents are taken from vapor pressure charts. A total of eight unknowns must then be calculated: X_A, X_B, X_C, Y_A, Y_B, Y_C, L and V, and since eight independent equations are available a direct solution is possible. It is simpler, however, to solve by trial and error.

Combining Equations (2) and (5), (3) and (6), (4) and (7), respectively, with Equation (1):

$$\frac{X_A}{X'_A} = \frac{100}{L + \frac{p_A}{P}(100\text{-}L)} \qquad (9)$$

$$\frac{X_B}{X'_B} = \frac{100}{L + \frac{p_B}{P}(100\text{-}L)} \qquad (10)$$

$$\frac{X_C}{X'_C} = \frac{100}{L + \frac{p_C}{P}(100\text{-}L)} \qquad (11)$$

X_A, X_B, and X_C may be calculated by assigning a value to L and employing Equations (9), (10), and (11). The correctness of the assumed value of L may then be tested by the remaining independent equation, No. (8).

It is possible, however, to develop curves for various values of p/P with X/X' and L, respectively, as ordinate and abscissa. One of these charts, plotted from Equation (9), is shown in the accompanying cut.

To apply the curves it is first necessary to determine values of p/P for each constituent. Considering one component at a time, enter the chart at an assumed value of L, proceed upward to the curve representing the

* Connected with the Lummus Co., New York, N. Y.

appropriate ratio of p/P, and thence horizontally to the corresponding value of ratio X/X'. The values of X are then determined by simple multiplication:

$$X_A = X'_A \times \frac{X_A}{X'_A} \qquad (12)$$

$$X_B = X'_B \times \frac{X_B}{X'_B} \qquad (13)$$

$$X_C = X'_C \times \frac{X_C}{X'_C} \qquad (14)$$

The correctness of the assumed value of L should then be tested by Equation (8).

This method may be illustrated by the following example:

Given:
Temperature = 45° F.
Operating pressure (p) = 760 mm.

Components	X'	p (mm.)
Propane	0.108	4,400
Butane	0.674	1,010
Pentane	0.218	250
	1.000	

Determine value of p/P for each constituent:

Components	$\frac{p}{P} = (K)$
Propane	4,400 / 760 = 5.79
Butane	1,010 / 760 = 1.33
Pentane	250 / 760 = 0.329

Trial 1—Assume $L = 35$, $V = 65$.

Components (X')	× $\left(\frac{X}{X'}\right)^*$ =	X
Propane 0.108	× 0.240	0.026
Butane 0.674	× 0.824	0.555
Pentane 0.218	× 1.775	0.387
1.000		0.968

* Taken from the graph.

Trial 2—Assume $L = 25$, $V = 75$. By a similar calculation:

Components	X
Propane	0.024
Butane	0.540
Pentane	0.439
	1.003

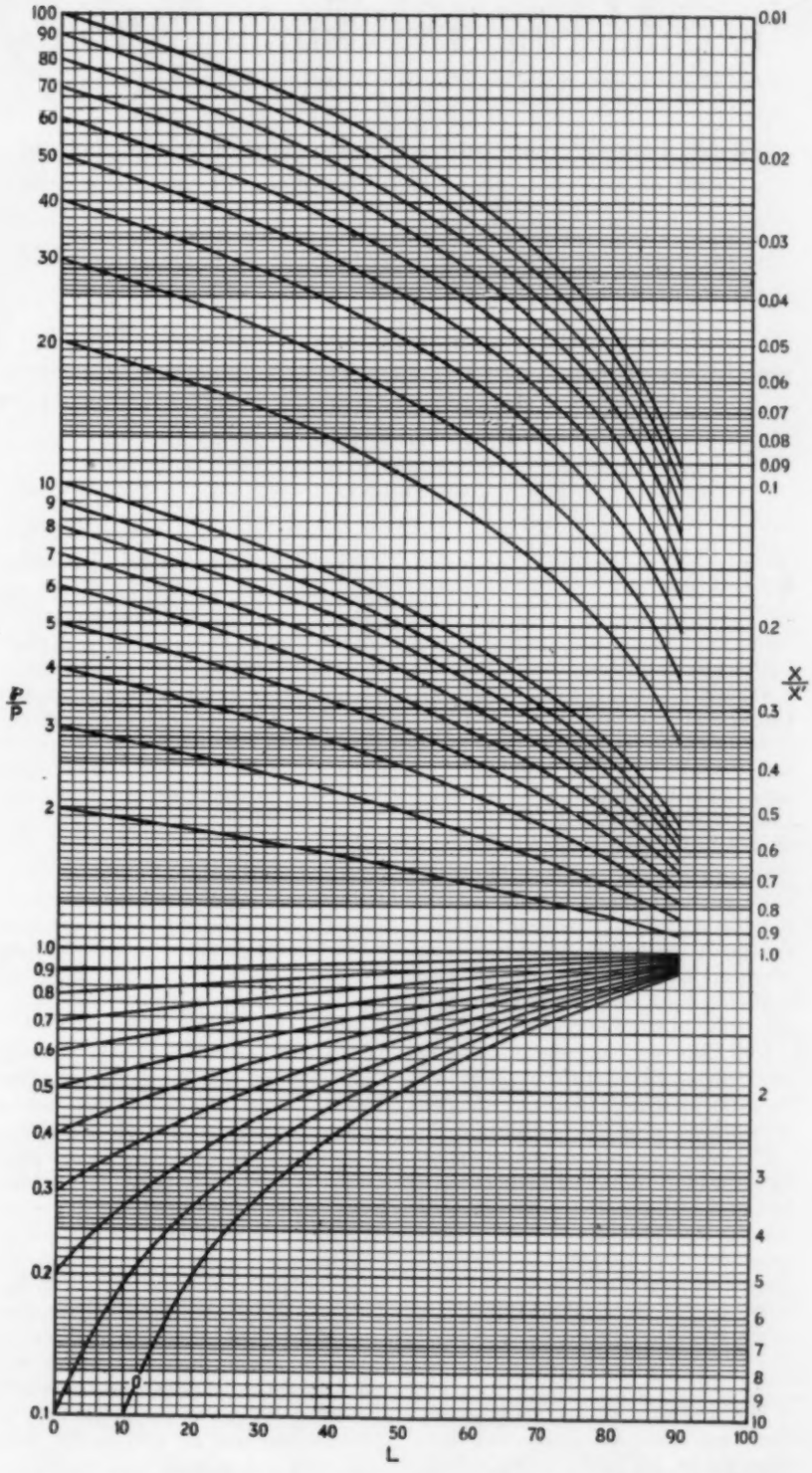
Trial 3—Assume $L = 25.8$, $V = 74.2$.

Components	X
Propane	0.024
Butane	0.542
Pentane	0.434
	1.000

Since the sum of the X-values is unity, the last assumed value of L is correct. The composition of both liquid and vapor phases are determined by a balance of materials.

Usually one of the constituents will prove to be the controlling factor. When this is the case, the curves make it possible to accurately judge the effect of varying L.

A set of curves similar to those illustrated may be developed for the vapor phase. Practical working charts require a great many intermediate curves, and are not included in this report because they cannot be reduced to the size of a magazine page.



With this chart the long and tedious procedure for solving equilibrium problems is greatly simplified. The chart is applicable to any system involving two or more components that follow Raoult's law, provided two of the components form mixtures having vapor pressures intermediate between those of the pure components. The symbols are defined on the opposite page

Engineering Department Profits

There's a big difference between profitable operation and showing a profit on the company's books—especially in the case of the engineering and research departments. The author tells how these departments can show a profit even though they may be classed among expenses.

H. A. TOULMIN, Jr.
Toulmin & Toulmin
New York, N. Y.

COST ACCOUNTANTS invariably classify the engineering, research, invention and development departments as "expense" departments, as distinguished from the "productive" departments which directly, and evidently, provide profits. This procedure is, ordinarily, entirely sound from a cost accounting point of view. Unfortunately, it is all too true from the necessarily hard-boiled point of view of management. Hence the usual answer to requests from the chief engineer who seeks needed appropriations: "Our overhead expense is already too heavy—and yours is an overhead expense. The funds we have available must go to departments that can bring in definite profits."

It is, however, entirely possible to make the accounts of the development department show a profit. A number of concerns have accomplished it.

Products that can be sold profitably by an engineering department are its inventions. Patentable developments are the true products of engineering, development and research in the same sense that forgings are credited to the forge shop or screw machine products to the machine shop.

Record All Inventions

The first step is to keep a systematic record of all inventions. This must not be left to the individual designer or engineer as, traditionally, his view is that there is little that is invention. He usually believes that all that he does is just good engineering. Therefore, forms should be provided for recording all ideas, patentable or not. Some plants supply each drawing board with a number of printed forms or conception booklets for the recording of each design or development, if it does not go to the final design stage.

These records are passed on to some central agency—usually an engineering clerk. He is charged with collecting not only these idea sheets, but also blue-prints of each new design or machine, product or process. A description of the operation of the machinery is attached in a folder. This goes to the patent attorney for determination of patentability in view of his knowledge of that particular business and the prior patents already issued.

Patent Licenses

In some corporations, his report is accepted by endorsements and comments of the commercial and manufacturing departments on the importance of the subject. The sales department is often helpful in determining the commercial importance of the invention. Here is one of the corner stones of the plan for making the engineering department a profit-maker. If the commercial department indicates that the development in question is something that other members of the industry can use and under which a system of patent licenses to competitors can be worked out, then the idea is a valuable one worth protecting. Sales and manufacturing departments are interested because sales prices of competitors' products can be controlled and profits over costs of manufacturing secured. This means steady labor conditions, purchase of the latest machinery and good commissions for the entire sales force.

Of course, when these licenses are granted, a license fee is paid by the competitors, which should be credited as income to the engineering department to be marked up as its contribution to profits.

In other cases, the company may have desired to use its competitors' patents, but could not enter a fruitful market for fear of expensive patent litigation. However, if the sales department has new inventions which may be traded, a cross-license under each others' patents can be worked out between the two companies, opening up new avenues for profits for themselves and increasing benefits for the trade. Here again the savings in royalty, expense of patent litigation and value of increased profits may be credited to the engineering department.

Byproduct Invention

Again, in many companies, a vast amount of byproduct invention is thrown away because it does not directly affect the company through its line of sales. Often such ideas are of great importance to other trades and industries. For instance, one of the large steel companies permits its employees to sell their inventions to non-competitors so long as the company gets a free license in its own fields. Often a special machine that is very costly for a limited use in one industry can be of general application in another, and the design and patent rights can be sold to non-competitors. For instance, a special machine for assembling fans may be useful in assembling cans; a conveyor system in shoe manufacturing was found useful in the food products field; and an invention for hair drying in beauty parlors was revolutionary in drying lacquers on automobiles.

Here again these sales of patentable ideas to non-competitors are credited to the engineering and research departments as their income. Often a special patent committee, consisting of the sales promotion department head, the chief engineer and the patent attorney, systematically explores these outside fields for the merchandising of byproducts of research and invention. Then, of course, the credit goes to the engineering department for resulting profit to the company.

So the next time the chief engineer asks for an appropriation, the answer may well be "It's yours. Your department earned a nice profit last year."

Chemical Engineer's BOOKSHELF

New Titles, Editions and Authors

DISTILLATION, III

ELEMENTS OF FRACTIONAL DISTILLATION. Third Edition. By *Clark Shove Robinson* and *Edwin Richard Gilliland*. Published by McGraw-Hill Book Co., Inc., New York, N. Y., 1939. 267 pages. Price, $3.00.

Reviewed by *D. B. Keyes*

DISTILLATION, and especially fractional distillation, is undoubtedly the most interesting unit operation for the chemical engineer. Unfortunately, it is not a simple subject or, at least it has not been found to be an easy matter to explain the fundamentals of fractional distillation to the average student nor the layman. Furthermore, in spite of the immense amount of excellent work that has been done leading to the design of fractionating columns, we have not as yet been able successfully to determine in advance the exact height of a particular type of column for a particular purpose. Any book that will review the entire field and condense the more important matter so that the average student can readily obtain a clear picture of what has already been done is a welcome addition to the literature.

The third edition of "The Elements of Fractional Distillation," by Robinson and his colleague Gilliland, comes nearer to fulfilling our requirements in the educational world than any other treatise on the subject.

The third edition starts in as in former editions with a brief summary of the phase rule, gas laws, solutions, simple distillation and partial condensation. In order to illustrate this fundamental matter, there are chapters immediately following on ammonia, benzolized wash oil, methyl alcohol, and ethyl alcohol.

Perhaps the most interesting chapters from the student's standpoint are the ones on rectification of binary mixtures, complex mixtures, and multi-component mixtures. It is in these chapters that a distinct improvement has been made in the text over former editions. New material appearing in the literature has been well abstracted and explained. It is true, of course, that no two distillation experts can agree on the preferred method of attack on complex mixtures, but the authors have made a very satisfactory selection from the standpoint of the university worker.

The illustrations on hydrocarbons, naphtha, and petroleum distillation, as well as the final chapter on continuous distillation will be of interest to the student. The difficulty encountered in actual column design is brought out in the chapters on column performance and the condenser. It is hoped that future editions will include more material of this character.

It is predicted that this third edition of "Elements of Fractional Distillation" by Robinson and Gilliland will find considerable use as an elementary textbook on the subject in all universities where unit operations are taught in detail. Furthermore, it should be of real interest to all column designers who wish to read and digest the more recent methods of determining the number of theoretical plates required for multi-component mixtures.

HYDROCARBON DATA

PHYSICAL CONSTANTS OF THE PRINCIPAL HYDROCARBONS. Second Edition. By *M. P. Doss*. Published by the Texas Co., New York, N. Y., 152 pages.

Reviewed by *J. H. Boyd, Jr.*

OF INTEREST TO PETROLEUM TECHNOLOGISTS and others concerned with hydrocarbon chemistry is this tabulation by chemical classes of data on the physical properties of hydrocarbons. The author has done a real service in bringing together the data on some 1,300 hydrocarbons. The bibliography contains 1,397 references. A useful feature of the book is the provision of blank pages for the inclusion of data on additional hydrocarbons as they become available.

The properties included are specific gravity, melting and boiling points, index of refraction, viscosity, specific heat, heats of vaporization and combustion, aniline critical temperature of solution, thermal expansion, critical data, vapor pressure, octane number, surface tension and flash point.

HEAT TREATMENT OF STEEL

STEEL AND ITS HEAT TREATMENT. Fourth Edition, rewritten and reset. Volume I. By *D. K. Bullens*. Published by John Wiley & Sons, New York, N. Y., 445 pages. Price, $4.50.

Reviewed by *Edward S. Johnson*

HERE IS A WORK that has proved its metal over the years by three editions and is now entering upon the fourth. The first appeared about 25 years ago. Again the advances in the art, the fundamental metallurgical significance of the subject, and its applications in the steel industry necessitate revision and extension. The voluminous matter at hand warrants, it is believed, a two volume treatise.

Volume I, under review, deals with principles, processes, and control. The unique, perhaps yet somewhat mystic, mechanism of the behavior of steel in solid form under the action of heat far below the melting point—but within comparatively narrow limits of temperature—is set forth clearly in text and by adequate use of graphs, micrographs and halftones.

Section I considers with emphasis the necessity of the standard physical tests before planning heat-testing; more important than the chemical analysis even. Further, the principles of hardening, including the toughening of the metal, and curious behavior under what is known as "precipitation hardening," in application to low carbon steels, are discussed. Carburizing, nitriding, and the heat treating of these products has received extensive explanation in text of Section II. Heat treating control on a manufacturing scale is the subject of Section III. The uses of the many forms of equipment of precision for handling the various problems are reviewed in detail.

ABOUT PETROLEUM. By *J. G. Crowther*. Published by The Oxford University Press, New York, N. Y., 1938. 181 pages. Price, $2.25.

LAST YEAR Oxford University Press published the great four volume treatise "The Science of Petroleum" edited by

Dunstan, Nash, Brooks and, Tizard (See *Chem. & Met*, p. 559, October 1938). Subsequently, the same publishers arranged with this popular science writer to prepare this little book as a help to those who would like a simple introduction to the topics discussed so authoritatively in the other volumes. The result is a thoroughly readable text for the layman who seeks an accurate source of elementary information about petroleum—from the theory of its origin and its place in the history of civilization through the separate stages of technology of oilfield production, refining, and marketing of its products.

FATS, OILS, WAXES

UTILIZATION OF FATS. By *H. K. Dean.* Forward by *T. P. Hilditch.* Published by Chemical Publishing Co. New York, N. Y. 292 pages. Price, $6.

Reviewed by *W. L. Abramowitz*

ALTHOUGH oils and fats and their derivatives as soaps have been utilized in vast tonnages since earliest antiquity, it is only within recent years that chemists and chemical engineers have deigned to study systematically this branch of raw materials considered over long as too simple for high-powered research. The progress made can be evidenced by the fact that there now exists some 3,000 United States patents on the purification, isolation, and utilization of fatty materials and, of these, almost a thousand deal with sulphonation alone. The Germans are still the leaders in this field and their new autarchy and ersatz programs are keeping them well to the fore as exemplified by their noteworthy progress in the preparation of synthetic fats by oxidation of petroleums and hydrogenation products of coal. There is still no literature in the English language to rival their recent Schonfeld.

This new book by Dean is an excellent attempt to summarize in English the new developments in the field of fats and oils. It is unfortunate that cost considerations prevented more elaboration. The volume reviews the extraction and refining of fats, oils, waxes, a study of their constituents and chemical and physical properties, analytical methods, synthetic glycerides, hydrogenation of fats, drying and semi-drying oils, theory of saponification, and the preparation of soaps. Of special significance are the chapters dealing with blown, bodied, vulcanized and sulphonated fatty materials. A section on the industrial application of fats and oils includes cosmetic, textile, leather oils, and surface active agents. There are extensive bibliographies for each section and copious reference to patents, the latter of which would be more serviceable to American readers had they referred to U.S. rather than to foreign patents.

UNDERGROUND CORROSION

SOIL CORROSION AND PIPE LINE PROTECTION. By *Scott Ewing.* Published by American Gas Association, 420 Lexington Ave., New York, N. Y., 1938. 277 pages. Price, $2.50.

Reviewed by *R. S. McBride*

"THIS VOLUME is offered as a collection of information relating to the subject of the corrosion of underground piping systems and its prevention. It is largely the result of sifting and collecting in an organized manner the vast amount of information heretofore published on the subject. The demand for this information in convenient form has been widespread, and it is hoped that this book will be helpful to the engineers and operators of underground piping systems."

This is the author's own statement of his purpose, as given in the preface of the work, and any reviewer will say that he has succeeded admirably in his effort. Much of the material which has hitherto been available only in fragments, scattered through the records of A.G.A. proceedings and in other literature, is here brought together in the most usable form.

As a product of American Gas Association, the volume naturally relates to those pipelines for long-distance transmission and city distribution which handle natural gas and manufactured gas. But soils and pipe in contact act just the same whether it happens to be such public utility gas supply inside or some other gas or liquid which chemical process industry wishes to move underground. Much of the information here given is therefore directly applicable to the problems of the chemical engineer in other divisions of process industry. Any enterprise which has many underground structures, and is troubled by soil corrosion on them, will do well to have this book carefully studied by the technical men responsible for installation, maintenance, and repair of such equipment.

INDUSTRIAL HYGIENE

ESTIMATION OF POISONOUS GASES AND VAPORS IN THE AIR. By *A. S. Zhitkova.* Translated from the Russian by *J. B. Ficklen.* Published by "Service to Industry", Hartford, Conn., 1938. 198 pages. Price, $3.

IT IS WELL KNOWN that there is intense chemical development, testing and research in progress in the Soviet Union and new journals have appeared in great numbers. Yet it has been difficult to gage without bias the caliber of the work because of the obstacle of the language and inaccessibility of the publications. The Soviet Union prides itself on its efforts in the field of industrial hygiene and the present book is a summation of the analytical methods in use in that country for controlling noxious impurities in the atmosphere in factories and in chemical plants.

In an analysis for industrial hygiene where minute quantities of deleterious chemicals are present, it is necessary to find specific reactions which allow the detection and estimation of components without isolation. This volume is one of the first to present systematically detailed procedures.

Useful tables are given of threshold and fatal toxicities of the most important substances. The procedures are quite detailed and readily followed. Theory and methods of computation are also explained. Unfortunately, most of the basic references proving the accuracy of the methods are to Russian publications obtainable only with great difficulty in the United States. But the book is well worth while for those concerned with minimizing industrial chemical hazards.

WASTE REDUCTION

GRAPHIC ROUTES TO GREATER PROFITS. By *John W. Esterline.* Published by The Esterline-Angus Co., Indianapolis, Ind., 1938. 320 pages. Price, $3.

USE OF instruments for increasing the efficiency of industrial operations is the subject of this interesting case-study book. For many years Mr. Esterline's company has been accumulating specific examples of cases where wastes have been uncovered, losses checked and efficiences improved when "graphic" instruments were put on the job. Ranging throughout all industry in its more than 250 studies, the book demonstrates many possible improvements and, inferentially, suggests many more. Among the most enlightening examples are those fortuitous cases where totally unexpected difficulties were laid bare by the record chart. Highly illustrated and containing numerous reproductions of the charts which disclosed the troubles, the book should be a readable and valuable addition to the library of every plant engineer.

BALL MILLING

CONCLUSIONS FROM EXPERIMENTS IN GRINDING. By *Will H. Coghill* and *Fred D. DeVaney.* Published in Vol. 13, No. 1, Technical Series Bulletin of Missouri School of Mines and Metallurgy, Rolla, Mo., 1938. 102 pages.

THIS REPORT, covering an extended investigation carried out in cooperation between the U. S. Bureau of Mines and the Missouri School of Mines, summarizes in easy, readable fashion several earlier papers by the authors, and assays

a large part of the literature on the current state of the art in ball milling. Many of the variables in milling have been investigated and the authors' authoritative conclusions presented. Particularly useful is the summary section on "Cardinal Points in Grinding."

ORGANICS

ORGANIC SYNTHESES, VOL. 18. Edited by *R. C. Fuson*. Published by John Wiley and Sons, Inc., New York, N. Y., 1938. 88 pages. Price, $1.75.

LITTLE that is complimentary has been left unsaid concerning these fine publications which appear periodically. They are fast providing a dependable background of organic chemical procedures, accumulatively indexed and readily available. The present volume describes the preparation, among others, of allylamine, barbituric acid, difluorobiphenyl, diphenylselenide, taurine and methylaminodiacetic acid.

CATALOGS AND DIRECTORIES

WHO'S WHO IN AMERICA, 1938–1939 (VOL. 20). Edited by *Albert Nelson Marquis*. Published by A. N. Marquis Co., Chicago, Ill. 2,919 pages.

WE DON'T KNOW whether it's civilization progressing or simply that the crack in the door is being widened, but the fact is that 2,545 brand new names have been admitted to this red book of prominent Americans. This makes a grand total of 31,545 biographical sketches in the new edition, most of which are complete up to 1938.

They are arranged not only alphabetically, but also geographically. In addition to the biographical section there is a valuable educational index of schools and colleges in the United States.

NORTH CAROLINA INDUSTRIAL DIRECTORY AND REFERENCE BOOK. Compiled under direction of the Division of Commerce and Industry. By *J. T. Anderson*. *Industrial Engineer*, Raleigh, N. C., 1938. 932 pages. Price, $7.50.

THIS VOLUME contains a state-wide list of manufacturers classified according to types of industries, a similarly treated listing of industries by counties, all industries and commercial houses listed by towns and cities, and statistical data and summaries for the counties and the state. The processing field are subdivided into heavy chemical, fertilizer, pulp and paper, leather and related industries. The locations of the offices and plants are given as well as the number of employees. These and a wealth of other statistical information about the state make this book of value to the student of industry.

TEXTBOOKS

TEXTBOOK OF ORGANIC CHEMISTRY. By *G. H. Richter*. Published by John Wiley & Sons, New York, N. Y. 680 pages. Price, $4.

THERE ARE MANY text books of organic chemistry, but few good ones and fewer still at a reasonable cost. For mature engineers in industry, there is little point in discussing the pedagogical aspects of this volume which is intended for the average one year course in organic chemistry. But for the man in industry who wants a lucid and fairly comprehensive text for review or for quick reference, this book is heartily recommended. It does not pretend to be adapted for the requirements of organic chemical research.

PHYSIK. By *Dr. Paul Wessel* and *Dr. V. Riederer von Paar*. Published by Ernest Reinhardt Co., Munich, Germany. 1938. 514 pages.

THIS IS an elementary textbook in Physics for the first or second year college student. It covers the usual principles of physics with a section for questions and answers and one with tables commonly used in the various fields of physics. The senior author, who is now a lecturer at Wigan Technical College in England, chose as his objective to prepare a "practical modern physics with special application for engineering and chemistry."

FOR THE ANALYTICAL LIBRARY

Although Chem. & Met. *does not pretend to serve the requirements of analytical laboratories, every plant in the process industries must give some attention to the laboratory end of its work. Therefore we take this opportunity to summarize briefly a few of the new analytical books which should be of value not only to the laboratory libraries, but to the students and prospective laboratory workers as well.—Editor.*

THEORETICAL QUALITATIVE ANALYSIS. By *J. H. Reedy*. Published by McGraw-Hill Book Co., New York, N. Y., 1938. 451 pages. Price, $1.50.

THIS IS A BOOK for the student rather than for the industrial worker. It is intended to furnish the student with the facts and theories forming the basis for qualitative analysis. The most important section seems to be the one on ionization, a subject frequently left, at least partially, to the imagination of the student.

QUANTITATIVE ANALYSIS. By *Eugene W. Kanning*. Published by Prentice-Hall, Inc., New York, N. Y., 1938. 304 pages. Price, $2.75.

This is solely a text for the elementary student of quantitative analysis. However, since the student is a potential industrial worker it is important that his background be not only theoretical, but utilitarian as well. Therefore, in contrast to most very elementary texts, this author attempts to give the student a background for subsequent industrial work by dividing the book into two sections: the first, theoretical, and the second, practical applications of this theory. Finally, there is a group of questions and answers pertinent to the various analyses.

A SYSTEM OF CHEMICAL ANALYSIS. By *Ernest H. Swift*. Published by Prentice-Hall, Inc., New York, N. Y., 1939. 588 pages. Price, $6.00.

A VALIANT ATTEMPT is made to bridge the gap between the student and industrial worker. The various conventional systems are supplanted by the more recently developed techniques of spectrography and microchemistry. Distribution and distillation methods are frequently substituted for the more traditional precipitation. There is a definite attempt to correlate qualitative and quantitative analyses since the author feels that the qualitative methods learned in an elementary course are insufficient for accurate and detailed quantitative analysis. Long discussions are frequently appended for the purpose of bringing to the mind of the "future industrial worker" the fact that much thought and reasoning is required in addition to the straight simple laboratory experiment of the "student."

GAS ANALYSIS. By *A. McCulloch*. Published by H. F. & G. Witherby, London, England, 1938. 166 pages. Price, 7/6 net.

SINCE FUEL TECHNOLOGY occupies a large place of its own, this author has felt it necessary to devote a book to the sole subject of gas analysis for those students interested primarily in fuels. The author gives not only the methods of determination of the principal gases, but also describes the most important types of apparatus used therefor. There are valuable tables appended on temperature corrections, properties of gases, and volume factors.

SPECTOGRAPHIC ANALYSIS IN GREAT BRITAIN. Edited by *A. C. Candler*. Published By Adam Hilger, London, England, 1939. 80 pages. Price, 7/6 net.

BY ILLUSTRATING the use of the spectrograph for analytical work in twenty-eight British factories the editor attempts to show its superiority over chemical analysis. Traces of impurities are often revealed by the spectrograph which might otherwise go unnoticed. The fields covered in this little book are indeed diverse covering alloy steels, lead and copper, zinc and cadmium, aluminum and light alloys, precious metals, glasses, paints, fabrics, soils and plants, art, archeology and crime.

Nomographic Chart for Temperature Correction of Nitric Acid Density And Interconversion of Physical Properties

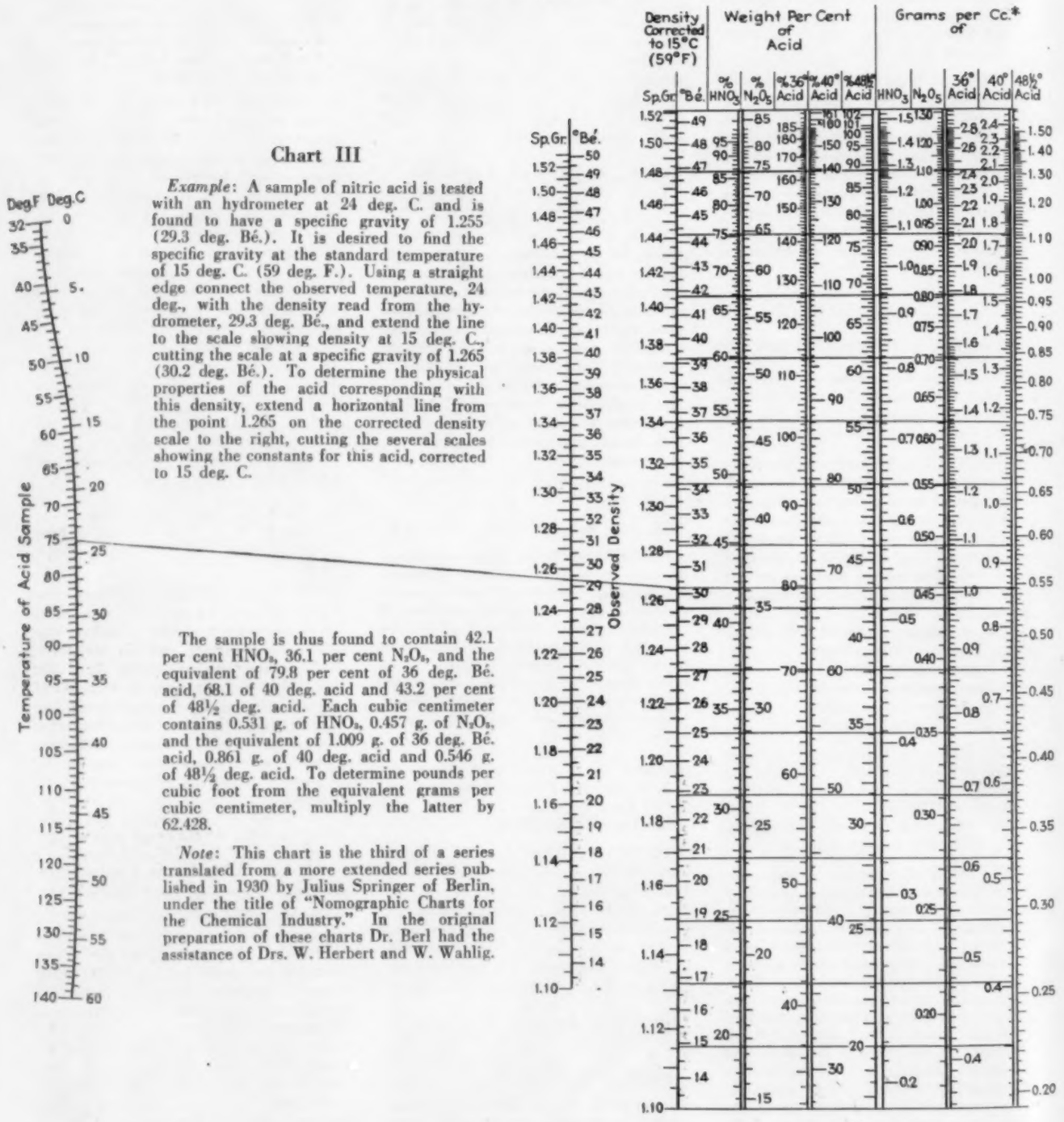
By ERNST BERL
Research Professor
Carnegie Institute of Technology
Pittsburgh, Pa.

Chart III

Example: A sample of nitric acid is tested with an hydrometer at 24 deg. C. and is found to have a specific gravity of 1.255 (29.3 deg. Bé.). It is desired to find the specific gravity at the standard temperature of 15 deg. C. (59 deg. F.). Using a straight edge connect the observed temperature, 24 deg., with the density read from the hydrometer, 29.3 deg. Bé., and extend the line to the scale showing density at 15 deg. C., cutting the scale at a specific gravity of 1.265 (30.2 deg. Bé.). To determine the physical properties of the acid corresponding with this density, extend a horizontal line from the point 1.265 on the corrected density scale to the right, cutting the several scales showing the constants for this acid, corrected to 15 deg. C.

The sample is thus found to contain 42.1 per cent HNO_3, 36.1 per cent N_2O_5, and the equivalent of 79.8 per cent of 36 deg. Bé. acid, 68.1 of 40 deg. acid and 43.2 per cent of 48½ deg. acid. Each cubic centimeter contains 0.531 g. of HNO_3, 0.457 g. of N_2O_5, and the equivalent of 1.009 g. of 36 deg. Bé. acid, 0.861 g. of 40 deg. acid and 0.546 g. of 48½ deg. acid. To determine pounds per cubic foot from the equivalent grams per cubic centimeter, multiply the latter by 62.428.

Note: This chart is the third of a series translated from a more extended series published in 1930 by Julius Springer of Berlin, under the title of "Nomographic Charts for the Chemical Industry." In the original preparation of these charts Dr. Berl had the assistance of Drs. W. Herbert and W. Wahlig.



*For pounds per cubic foot multiply by 62.428.

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Machinery, Materials and Products

Automatic Bin Control

TELLEVEL is the name of a new automatic storage bin control that has been put on the market by Stephens-Adamson Mfg. Co., Aurora, Ill. Designed for automatically controlling the level of materials in bins or hoppers, the device is also suitable for controlling the level of liquid in storage tanks. The device consists of three mercury switches in series, arranged in a cast aluminum housing from which a rod terminated in a Bakelite sphere extends downward. The housing is suspended from above by the conduit pipe, and swings freely as the Bakelite sphere is contacted by the material. Tilting of the device, by contact of the material entering the bin, breaks the circuit in one or more of the switches and stops the conveyor or elevator feeding the bin. A second Tellevel may be installed, if desired, in the bottom of the bin, to start the conveyor at a predetermined low level of material. A simple change in the wiring permits shifting the control from automatic to manual.

Turbine-Operated Pump

DESIGNED originally for use as a locomotive boiler feed pump and now offered for industrial service, a small-diameter, high-speed centrifugal pump, operated by a steam turbine, is being manufactured by the J. S. Coffin, Jr., Co., Englewood, N. J. Operating at a nominal speed of 7,150 r.p.m., the peripheral speeds are nevertheless low on account of small diameter. The pump operates at pressures up to 500 lb. per sq.in., delivering up to 350 g.p.m. Turbine and pump unit are mounted on the same shaft. The turbine and bearing casing is a single massive steel casting which includes the steam chest and emergency governor housing. The pump casing is overhung on the main casing and the single-stage impeller is overhung on the shaft on a solid hub. The pump is packed against low pressure only, with very light packing contact, employing a special self-adjusting packing. The turbine has a single pressure stage and two velocity stages and is equipped with a calibrated-spring-loaded governor which stops the pump at 2,000 and 3,000 r.p.m. above rated speed.

Pumps of this type have been in operation for 12 years on steam locomotives. A recent power plant test is stated to have shown operation for 19 months, 24 hours per day, without shutdown or adjustment. Packing adjustments between overhauls are stated never to be required. Only one pint of oil per month is necessary.

Magnetic Separator

A RECENT DEVELOPMENT of the Stearns Magnetic Mfg. Co., Milwaukee, Wis., is a magnetic separator designed to remove reluctant, minute magnetic particles from finely powdered materials. The Type V separator, shown in the accompanying illustration, is of the type in which the material to be purified is spread uniformly over the face of a magnet as a fine rain. The impurities, contacting the pre-magnetized pole of the magnetic field are removed by a secondary or deflecting field. The housing is fabricated from non-magnetic material and a part of the housing is hinged to permit opening for thorough cleaning. The machine is without moving parts and is stated to be well adapted for use in batch processes.

Modernized Compressors

NINE NEW MODELS of air compressor have recently been announced by the Quincy Compressor Co., Quincy, Ill. Various mechanical refinements have been employed, including simplified construction, 12 per cent greater radiation area on the cylinders, and stream-lined appearance. Sizes range from 2.8 to 30.1 cu. ft. per minute piston displacement. Single-stage, single-stage duplex-cylinder and two-stage models are available.

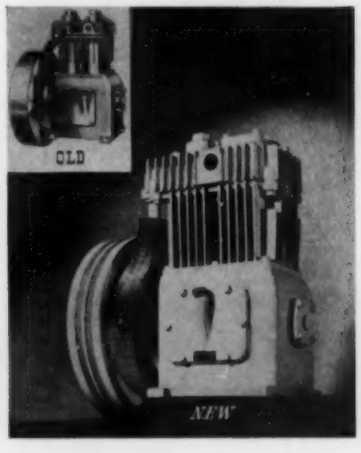
Type V magnetic separator

Carboy Truck

A NEW DESIGN of lift truck, for picking up and transporting carboys, has been announced by the Yale & Towne Manufacturing Co., Philadelphia, Pa. The

Lift truck for carboys

Improved Quincy compressor



truck has a 6-in. mechanical lift, secured through a downward movement of the handle. An automotive type release check is installed in each lower side frame and the two checks, working together, permit smooth lowering of the load, without jar. The truck is equipped with roller bearings for easy movement.

Neoprene Rod Packings

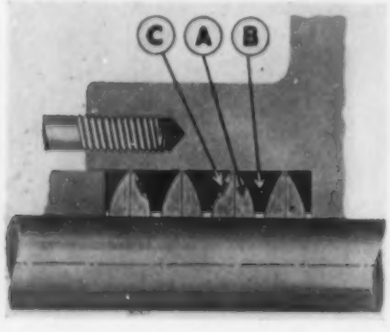
A NEW TYPE of pump rod packing designed specifically for extra severe service, and employing neoprene and metal in combination, has been introduced by the Rodpak Mfg. Co., San Francisco, Calif. In the accompanying illustration, two metal rings at *A* serve as the sealing medium on the shaft. The metal used depends on the application. Between the several sets of rings are rings of neoprene at *B* which mate with the metal rings. Beryllium copper springs at *C* are embedded in the neoprene rings, serving in centrifugal applications to prevent the packing from turning with the shaft. When used on reciprocating rods, the springs exert an inward and downward pressure, offsetting any irregularity of the rod. This construction is said to provide a floating seal in that the metal rings seal the rod but do not touch the stuffing box, while the neoprene rings seal the stuffing box but do not touch the rod.

In an application on a compressor handling hydrogen and nitrogen at 170 lb. pressure, the new packing was reported to have lasted ten months as compared with one week for the packing previously used. On a pump handling hot kerosene at pressures as high as 8,000 lb., the new packing was still in service after 18 months, compared with replacement every few days for earlier packings.

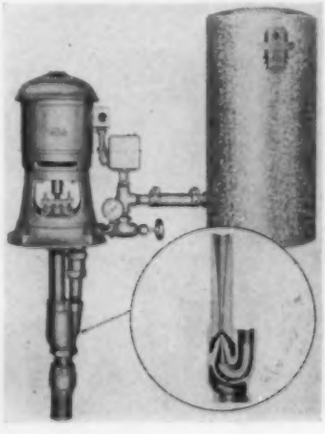
Jet Water Pump

SIMPLICITY of construction is an important feature of a new line of deep-well jet-type water pumps for industrial applications, made in sizes from ½ to 1 hp., and recently announced by the Westco Pump Div. of Micro-Westco, Inc., Bettendorf, Iowa. In this pump the impeller—the pump's only moving part—is above ground. This impeller provides water under pressure which passes through a jet placed in the well so as to lift additional water from the well. The impeller is machined from a single bronze casting and is driven by a vertically mounted capacitor-type motor. This arrangement is said to minimize noise and provide a steady non-pulsing stream of water.

New metal and neoprene rod packing



Jet-type deep-well pump



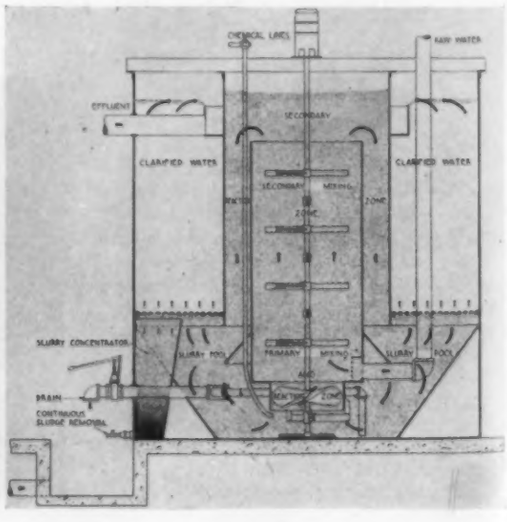
Improved Water Softener

INTERNATIONAL FILTER CO., 59 East Van Buren St., Chicago, Ill., has developed a new compact lime-soda water softening system, known as the Accelator, which accomplishes clarification without sedimentation. The new method is stated to soften water more completely in a shorter time, in smaller space, and at lower cost, than has previously been possible. The area of the Accelator is usually no larger than, and often less than, that of the filter. In the new process a body of slurry containing 1 or 2 per cent by weight of previously precipitated solids is circulating through the mixing and reaction zones and slurry pool. Treating chemicals first are mixed with the slurry, then the raw water is added to the chemical-slurry mixture. The effect of the conditioned slurry upon the chemical and physical reactions is such that equilibrium is obtained in a few moments. Separation of clear water takes place continuously over the entire area of the slurry pool, at the rate of 2 or 3 gal. per sq.ft. per min., or higher.

Although reaction of the treating chemicals with the water takes place almost instantaneously, a large part of the solids formed remains in colloidal suspension for a considerable time. Some of these materials remain in solution in a supersaturated condition. In the Accelator with several volumes of slurry circulated for each volume of raw water entering, the newly formed solids have a great opportunity to deposit by accretion on the particles present in the slurry.

The slurry formed is of such character that it does not tend to rise with the clarified water. As the amount of solids increases, a portion of the slurry is continuously skimmed from the surface. Continuous separation of the clarified water takes place simultaneously from a sharply defined slurry boundary line and the clear water, containing not over 5 to 10 parts per million of solids, rises to the clarified water discharge.

Cross section of new Accelator water softening equipment



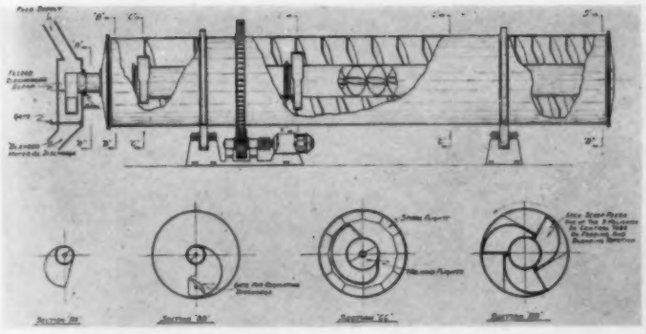
White-Print Machines

SEVERAL new models of printing machines for the production of white-background prints from tracings and other original material by the Ozalid process, have been announced by the Ozalid Corp., 354 Fourth Ave., New York, N. Y. Model A handles widths up to 42 in. at speeds up to 20 ft. per minute. Model E handles the same widths at speeds up to 30 in. per minute. Model D, an office machine, is of smaller size. All are completely automatic in operation.

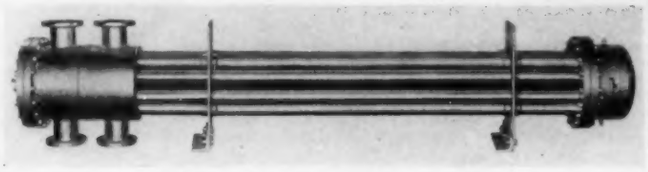
New Products

TWO NEW asbestos-filled Durez molding compounds have been announced by General Plastics, Inc., North Tonawanda, N. Y., bringing the number of asbestos-filled compositions made by the company to more than half a dozen. Both are heat resisting materials, Durez 38-443 having a heat resistance of 490 deg. F. and Durez 38-646 a resistance of 500 deg. F. The former has an impact strength of 0.23 (A.S.T.M.) and the latter. 0.19. Compressive strength of both is 28,000 (A.S.T.M.), and specific gravities, respectively, 1.80 and 1.59. The second has a flexural strength of 9,000 (A.S.T.M.), said to be higher than previously available.

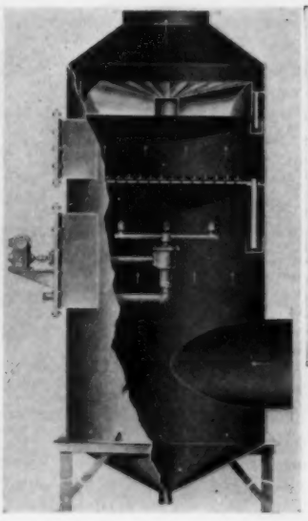
AMONG the new products announced recently by the Porcelain Enamel & Mfg. Co., Baltimore, Md., is Micronized clay, a clay produced by reduction in the



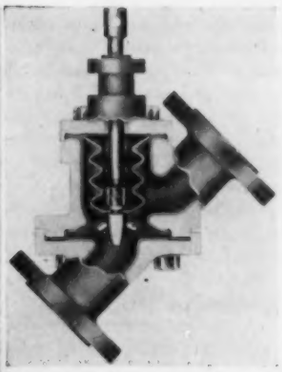
Sketch of Triplex dry blender showing internal construction



G-Fin Polysection heat exchanger



Cutaway view of new gas scrubber



Rubber-lined control valve

Micronizer to a grain size of 1 — 10 microns. The process is said to give a product of greater workability and improved suspension, which is cleaner and easier to handle. Pitting and scumming are minimized and the finished product is claimed to have a closer texture and to be more durable. Another new product of the company is an acid-resisting satin-finish enamel for architectural use, available in opaque, clear and black frit types. Mill additions of dulling agents are not required in producing the desired semi-matt finish.

TWO NEW synthetic waxes having much the character of carnauba wax have been introduced by The Beacon Co., 89 Bickford St., Boston, Mass., under the name of Carnaqua Waxes. These materials disperse readily in water to form stable emulsions which give films that are water insoluble. When such an emulsion is modified by "Resinoid-M" or a similar synthetic resin solution, glossy films which are completely waterproof and have other interesting properties are produced. The films are said to be extremely durable, to have a higher gloss than most other waxes, and to be suitable for use in bright-drying floor waxes, shoe polishes and similar applications. Literature giving additional information is available.

Triplex Dry Blender

WHAT IS described as an entirely new principle of mixing and blending of dry materials is employed in the new Triplex dry blender recently announced by the Patterson Foundry & Machine Co., East Liverpool, Ohio. This equipment, which is portrayed in the accompanying cutaway drawing, is a rotating cylinder, equipped with helicoid screw flights so arranged as to divide the material into thirds by geometric progression while at the same time the material is undergoing conventional mixing due to the rotation of the cylinder.

The material is fed to the blender at the left where it is picked up by a scoop and delivered to a single helicoid screw flight fastened to the outer shell. It travels one-third of the length of the blender where it enters a double helicoid screw flight, thus being divided into two distinct streams. When the third compartment is reached, the material enters a triple helicoid screw flight and divides into three streams.

Each of the three compartments of the outer cylinder is equipped with an individual scoop which picks up and deposits one-third of the material in the inner cylinder. Again it is divided into sections traveling left toward the starting point the length of one compartment, where one stream is permitted to return to the outer cylinder and a double stream is carried through to the second compartment. Another stream is dropped at the end of the second compartment and the third near the feed end of the machine.

One cycle of the mixer requires approximately 15 revolutions and four cycles cause 81 divisions, or practically complete mixing. Discharge may be arranged at the right-hand end, or may be accomplished from the feed end by reversing the direction of rotation. The power consumption of the equipment is said to be low while thorough blending is claimed, without the generation of internal heat or the crushing of particles.

Heat Exchanger

ESPECIALLY INTENDED for use with liquids of low heat conductivity or high viscosity is a new development in finned-tube heat exchangers known as the G-Fin Polysection, developed by the Griscom-Russell Co., 285 Madison Ave., New York, N. Y. The unit has seven U-bend heat transfer elements, with each straight length of tube inclosed in an individual shell. The single tube within each shell is surrounded by longitudinal fins mechanically embedded in the tube and forming an extension of the outside surface of the tube. The multiple shells are grouped in a compact assembly with all inlet and outlet connections at the stationary end.

Gas Scrubber

FOR THE REMOVAL of fog, dust and other particles from gas and air, Peabody Engineering Corp., 580 Fifth Ave., New York, N. Y., has perfected a new scrubber which separates impurities in a three-step process. Gas enters tangentially near the base of the scrubber where coarser particles separate by cyclonic action. The flow then passes upward through a zone of water or scrubbing liquid supplied by slowly rotating sprays at 10-15 lb. pressure. Wet by the liquid, the gas encounters a plate with coarse perforations from which the mixture of gas, dust and droplets is shot at a group of square impingement baffles where the final cleaning takes place. Here the scrubbing liquid traps the dust particles on the baffles, but the gas is deflected around the baffles and continues toward the outlet. One case is cited where a Peabody scrubber 4 ft. in diameter and 6 ft. in height did the same cleaning job as a packed tower 8 ft. in diameter and 130 ft. high.

Acid-Proof Valve

ACID-PROOF construction completely eliminating packing is the feature of a new rubber-lined valve developed especially for regulating the flow of ferric chloride solutions, recently put on the market by the Hasco Valve & Machine Co., 1819 West St. Paul Ave., Milwaukee, Wis. The valve is suitable for any acids except hydrofluoric and fuming

sulphuric, and highly oxidizing reagents and strong alkalis. All parts are completely lined with live rubber except the seat and plug which are of tantalum. The metal stem supporting the tantalum plug is protected by a rubber bellows. The valve is intended only for control purposes, and not for shut-off. Designed for control by an automatic ratio regulator, it is customarily operated by a hydraulically operated cylinder.

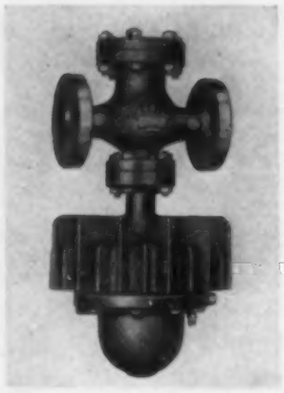
Equipment Briefs

FOR THE DETECTION of mercury vapor fumes, the General Electric Co., Schenectady, N. Y., has developed an improved instrument which consists of a light source giving off ultra violet rays that are absorbed by even minute traces of mercury vapor. The rays are used to illuminate a photoelectric cell. The air to be tested is drawn between the light source and the photocell and when it contains as little as one part of mercury per million of air, the absorption casts a shadow on the cell and reduces its current emission in proportion to the mercury concentration. The cell output is amplified and measured with either an indicator or recorder.

EMERGENCY protection for workers whose clothing may catch fire is afforded by a specially mounted fireproof blanket which is being marketed by the Davis Emergency Equipment Co., 55 Van Dam St., New York, N. Y. Normally, the blanket is wound on a vertical roller which is mounted on a wall or post. If the worker's clothes catch fire, or if it should be necessary for him to dash through flames to reach safety, he thrusts an arm through a catch-rope attached to the exposed edge of the blanket and, turning rapidly, wraps the blanket closely around himself.

SUPPLEMENTING its regular line of industrial lighting units, the General Electric Vapor Lamp Co., Hoboken, N. J., has introduced a 100-watt fluorescent lamp in the form of a tubular light source, 4 ft. in effective length. Ultra-violet radiations produced in the tube by means of a mercury vapor arc cause fluorescence of a coating within the tube and produce visible light at high efficiency. A comparison of 100-watt lamps shows that the fluorescent lamp produces 50 lumens per watt, the bulb-type mercury lamp 35 lumens per watt, and the incandescent lamp about one-third the output of the fluorescent type.

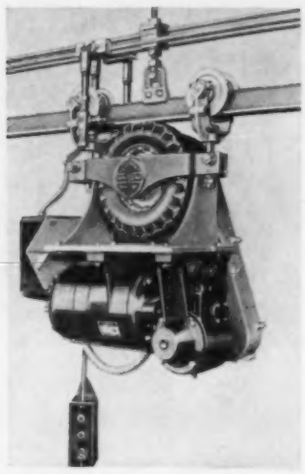
TO FACILITATE the handling of heavy cylinders of anhydrous ammonia, chlorine and other compressed gases, the Lewis-Shepard Sales Corp., 245 Walnut St., Watertown, Mass., has developed a special truck. The tank is easily clamped to the truck frame and the truck frame is then pulled back to carrying position, in which position the truck is balanced so that little effort is necessary to support the tank. Large diameter wheels and roller bearings permit the truck to run over rough floors with ease. One truck will carry various sizes of cylinder up to 15 in. diameter by 53 in. long.



Grove high-pressure reducing valve

MODEL XVO is the designation of a new line of heavy-duty diesel-engine-driven compressors, recently developed by the Ingersoll-Rand Co., 11 Broadway, New York, N. Y. These machines, entirely new in design, combine a horizontal, heavy-duty, double-acting compressor, with a heavy-duty V-type four-cycle diesel engine in a single compact and comparatively light-weight unit which operates at moderate speed. Sizes are available for free-air ratings of 625, 835 and 1,250 c.f.m. at 100 lb. pressure. Other compression cylinders in wide variety for air, gas and ammonia, are available for pressures ranging from vacuum to 5,000 lb. per sq.in., and higher.

BENJAMIN ELECTRIC MFG. CO., Des Plaines, Ill., has announced a new line of "daylight" fluorescent lamp diffuser units, particularly for use where a high degree of color discriminations is required. Two units are available, each of which is equipped with three fluorescent tubes mounted in individual troughs in a reflector of polished Alzak aluminum. The 18-in. size operates on 110-volt, 60-cycle a.c. current and the 36 in. size on either 110 or 220 volts. The 36-in. size, requiring approximately 105 watts, provides 3,240 lumens of 6,500 deg. Kelvin light, whereas a 1,000-watt incandescent light corrected to this same color temperature would have an absorption of about 88 per cent and a corrected lumen output of about 2,400 lumens.



Rubber-tire-driven conveyor

Reducing Valve

GROVE REGULATOR CO., 1729 Poplar St., Oakland, Calif., has announced a new steam reducing valve for pressures up to 1,500 lb. and temperatures to 950 deg. F. No springs or counterweights are used to motivate these valves. Instead an air dome is employed, closed by a diaphragm which is attached to the single-seated valve. Pressure within the air dome is preset to equal the desired outlet pressure, and this pressure pushes against the valve stem to open the valve. Another model now in use in the oil fields and on high pressure air has a capacity up to 6,000 lb. per sq.in.

Overhead Conveyor

MOTOVEYOR is the name of a new device for automatically transporting loads over an overhead track system. This has recently been put on the market by the Louden Machinery Co., Fairfield, Ia. As appears from the illustration, power is transmitted to the track by means of a rubber-tired drive wheel. Speeds ranging from 60 to 600 ft. per minute can be provided. The device may be built into a cab or step on a platform so that the operator can accompany the load, if desired. Overhead cranes may also be equipped with this drive mechanism.

MANUFACTURERS' LATEST PUBLICATIONS

Agitators. Patterson Foundry & Machine Co., East Liverpool, Ohio—4-page leaflet describing features of this company's improved 1939 streamlined Unipower motor-operated drive for agitators, built in all sizes from ½ to 100 hp.

Air Filters. American Air Filter Co., Louisville, Ky.—Bulletin 250—8-page bulletin describing in detail this company's new Electro-Matic air filter which combines in one apparatus electrical precipitation and automatic air filtration, using a self-cleaning viscous air filter.

Alloys. Haynes Stellite Co., Kokomo, Ind.—16-page summary of information on physical, mechanical and chemical properties of this company's principal alloys, with brief descriptions of each.

Apparatus. Clay-Adams Co., 44 East 23d St., New York City—Catalog 110—15 pages describing this company's laboratory centrifuges in power- and hand-operated models; also accessories.

Apparatus. Precision Scientific Co., 1750 North Springfield Ave., North Chicago, Ill.—Catalog 165—112-page spiral-bound catalog on a wide variety of apparatus for the testing of petroleum products.

Bearings. Johnson Bronze Co., New Castle, Pa.—Bulletin 390—72-page catalog on this company's bronze bearings and bushings, bronze bars, motor bearings, and graphited bronze bearings. Includes supplementary comprehensive price list.

Boilers. Combustion Engineering Co., 200 Madison Ave., New York City—Catalog BT-6—38-page book on this company's bent tube boilers, showing typical applications, construction details, special designs and also features of the company's manufacturing and testing facilities.

Books. Chemical Publishing Co. of New York, Inc., 148 Lafayette St., New York City—36-page catalog of technical books, both domestic and imported, covering chemistry, physics, mathematics, and various other sciences and branches of engineering.

Chemicals. The C. P. Chemical Solvents, Inc., 11 Park Place, New York City—48-page book on solvents, alcohols and extenders, with information on physical and chemical properties of this company's products, and suggestions as to their use.

Chemicals. Glyco Products Co., 148 Lafayette St., New York City—72-page revised edition of "Chemicals by Glyco," describing in detail this company's synthetic chemicals and resins, with information on uses and a large number of suggested formulas.

Chemicals. Rubber Service Div., Monsanto Chemical Co., Akron, Ohio—36-page book on Latex compounding, with information on chemicals, procedure and tests.

Compressors. Ingersoll-Rand Co., Phillipsburg, N. J.—Form 3063-A—24 pages describing construction and application of Class ES heavy-duty air and gas compressors in sizes from 10 to 125 hp. and pressures to 2,500 lb.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet 2125-C—4 pages describing explosion-proof motors; Leaflet 2183-A, describes construction of Type E direct-current motors and generators.

Electrical Equipment. Delta-Star Electric Co., 2400 Block Fulton St., Chicago, Ill.—Bulletin 38-D—168-page catalog on this company's bus and cable connectors; also Bulletin 33-B, 31 pages on indoor disconnecting switches and fuse mountings.

Electrical Equipment. Durakool, Inc., Elkhart, Ind.—Vol. 1, No. 1 of "Durakool Contacts," a new house organ featuring interesting applications of this company's mercury switches.

Electrical Equipment. The Pyle-National Co., 1334 North Kostner Ave., Chicago, Ill.—Bulletin 1105—14 pages on this company's explosion-proof, dust-proof Pylets, being electrical conduit wiring fittings, switch boxes, receptacles and similar devices in wide variety.

Electrical Equipment. Rockbestos Products Corp., New Haven, Conn.—Catalog No. 10-E—63-page loose-leaf catalog dealing in detail with this company's insulated wires, with data tables and information on applications.

Electrical Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Descriptive Data 29-080—4 pages describing this company's Type AB-20 De-Ion air circuit breakers with interrupting capacities to 20,000 amp.

Equipment. **Link-Belt Co.,** 307 North Michigan Ave., Chicago, Ill.—Catalog 1742—16 pages describing this company's straight-line collector for the removal of sludge from rectangular tanks used for settling in sewage treatment and water purification.

Equipment. Morse Bros. Machinery Co., P. O. Box 1708, Denver, Colo.—Bulletin 82—4 pages describing Weinig flotation machines made by this company, with information on construction and dimensions; also General Bulletin B-9, 4 pages briefly describing types of equipment made by this company, including disintegration equipment, feeders, classifiers, concentrators, thickeners and filters.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin W-319-B1A—Bulletin describing this company's high-pressure forged-steel-casing centrifugal pumps; W-360-B2, 4 pages on centrifugal mash pumps for breweries; C-1100-B2, 6 pages describing single- and two-stage Worthington-Carbondale refrigeration compressors built in the horizontal duplex type.

Evaporators. Buffalo Foundry & Machine Co., 1635 Fillmore Ave., Buffalo, N. Y.—Bulletin 319—16 pages completely describing this company's stainless steel evaporators for milk.

Fans. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Catalog 444—20 pages of description and engineering data on this company's Axiflo pressure fans in sizes from 18 to 60 in., for pressures as high as 25 in. w.g.

Feeders. Milton Roy, 2031 East Madison St., Philadelphia, Pa.—Bulletin 239—Leaflet describing this company's bypass chemical feeders for introducing chemical solutions into water lines, either as shots or proportional to flow rate.

Gaskets. Goetze Gasket & Packing Co., New Brunswick, N. J.—Leaflet describing and giving list prices on this company's metal jacketed and spiral wound gaskets for hand holes, tube caps and manholes of all types of boilers.

Grinding. Abbé Engineering Co., 50 Church St., New York City—Bulletin 46—Leaflet describing this company's impact grinding mill, its advantages and uses.

Hammer Mills. Pennsylvania Crusher Co., Liberty Trust Bldg., Philadelphia, Pa.—Bulletin 6000—15-page booklet describing this company's "Impactors," for large reduction ranges in the crushing of industrial minerals. Describes construction and performance of this cageless, reversible mill.

Heaters. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet 30-TE—4 pages describing this company's electric extended surface strip heaters, with charts on air heating; also leaflet on "Formed and Folded" heating elements for electric furnaces.

Heat Exchangers. Griscom-Russell Co., 285 Madison Ave., New York City—Bulletin 1601—24 pages on this company's Bentube sections, describing construction, typical installations and telling how the tubes automatically shed the scale.

Instruments. Bausch & Lomb Optical Co., Rochester, N. Y.—4-page leaflet describing this company's half-shadow saccharimeters.

Instruments. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio—Bulletin 105—16 pages describing this company's three-element air-operated system of feed water control; also Bulletin 194-A, 16 pages on this company's Synchro-Meter system of telemetering of flow and other indications.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletin 139—12 pages describing time recorders, their selection, application and use.

Instruments. Hardinge Co., York, Pa.—Bulletin 42—8 pages describing the control of grinding mills by sound and the "Electric Ear" which has been developed by this company for automatic control through maintaining the noise level of the mill constant.

Instruments. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.—Bulletin N-96S-709B—12 pages on this company's automatic pH control equipment for liming and gassing of beet juices. Also Catalog N-01-163, 32 pages on this company's combustion control equipment for boiler furnaces, with detailed description of all parts.

Instruments. Roller-Smith Co., Bethlehem, Pa.—Catalog 48—16 pages on round and rectangular electrical switchboard instruments, covering meters for voltage, current, power,-factor, frequency and other factors; also necessary accessories.

Lubrication. E. F. Houghton & Co., Third, American & Somerset Sts., Philadelphia, Pa.—Leaflet describing this company's "300" series of Sta-Put lubricants which are mineral oils, treated to produce higher film strength and greater load carrying capacity.

Metals. Allegheny-Ludlum Steel Corp., Pittsburgh, Pa.—Vol. 1, No. 1 of a new house organ, "Steel Horizons," a large and handsome publication dealing with the products of this company.

Power Transmission. American Leather Belting Association, 100 Gold St., New York City—4-page leaflet on latest horsepower ratings of flat leather belting with information on methods of correcting nominal rating for center-to-center distance, atmospheric conditions and other factors depending on service.

Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet 2199-C—4 pages describing this company's single-suction, single-stage, close-coupled utility pumps in sizes to 75 hp.; also Leaflet 2293, covering Type PO open-runner stock pumps for paper and chemical industry use.

Regulators. Grove Regulator Co., 1729 Poplar St., Oakland, Calif.—Bulletin 123—22 pages describing in detail the various types of pressure reducing regulators for air, gas and steam, made by this company.

Roofing. Republic Steel Corp., Advertising Dept., Cleveland, Ohio—Roofing Products Book ADV-320—32 pages on this company's steel roofing products with information on various types and complete data tables.

Safety. Jackson Electrode Holder Co., 15112 Mack Ave., Detroit, Mich.—Leaflet describing a number of varieties of the Jackson Eyeshield for the eye protection of industrial workers.

Screens. The J. H. Day Co., Cincinnati, Ohio—Bulletin 375—12 pages on this company's Ro-Ball stabilized gyrating screens, with information on construction, types, applications and dimensions.

Screens. Productive Equipment Corp., 4600 South Kedzie Ave., Chicago, Ill.—Bulletin 239—4 pages describing this company's Selectro vibrating screens, describing engineering features.

Tables. Stebbins Engineering & Mfg. Co., Watertown, N. Y.—11-page data book with tables giving capacity of tanks; areas and circumferences of circles by inches to 100 ft.; tables of spheres; and decimals of inches and feet.

Valves. Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn.—4-page leaflet describing construction of this company's Stellite-seated Hancock Duravalve.

Valve Operators. Philadelphia Gear Works, Limitorque Division, Erie Ave. and G St., Philadelphia, Pa.—4-page leaflet describing this company's Type M-5 Limitorque valve control, with information on construction, specifications and dimensions.

Chemical Engineering NEWS

Tariff Commission Gives Data On Trade with Germany

The Tariff Commission has issued a compilation of data on United States trade with Germany. The information will be of special interest in view of the recently announced application of the countervailing-duty provision of the tariff act to imports from Germany.

With the data on imports of individual commodities from Germany and Austria, there are included for purposes of comparison statistics of imports from other principal supplying countries and on the total from all sources. The tariff treatment of the various commodities is also shown. In the case of articles on which duties have been reduced in trade agreements, both the old and the new trade agreement rates are given, thus affording comparisons of the duties paid on such articles when imported from Germany and from countries not found to have discriminated against the United States. The comments on each commodity give such information as is available regarding domestic production of similar goods and regarding any special characteristics of the imports from Germany and Austria as compared with those of similar goods from other sources, foreign and domestic. The comments are designed to throw light on the importance of the German and Austrian imports to the economy of the United States and on the effect of the application of countervailing duties on the future course of imports.

United States imports from Germany, exclusive of the areas recently annexed, were valued at about 254 million dollars in 1929, fell to 73 million dollars in 1932, and thereafter, with some ups and downs in particular years, reached the low level of 64 million dollars in 1938. Last year imports from Germany were smaller than in any post-war year and accounted for only 3.3 per cent of our total imports as compared with 5.4 to 6 per cent in the years 1929 to 1933.

A number of factors are referred to by the Tariff Commission as responsible for the decline in the importance of Germany as a source of our imports. Among these are the increased exchange value of Germany's currency for the dollar, resulting from the reduction in the gold value of the dollar; and the difficulties of many German manufacturers in obtaining materials necessary for the production of goods of the quality formerly exported from Germany to this market. A third factor was, of course, the disinclination of many Americans to handle or use German goods.

Among the factors affecting our exports to Germany are the German trade policies which tend to force reductions of the imports from those countries which take smaller amounts of German goods than they export to Germany. Curtailment of our exports to Germany has also resulted from the National Socialist program of promoting domestic production of goods such as synthetic textile fibers to replace materials formerly imported.

The Tariff Commission also gives a brief description of the operation of the much-discussed "barter" procedure and analyzes the probable effects of the countervailing duties on imports effected through this procedure. These countervailing duties are to go into effect on April 23, 1939. It appears that as long as the price level in Germany and the exchange value of its currency for the dollar remain as at present, the tendency will be for many of the imports which have been effected through the "barter" procedure to decline or disappear as a result of the application of countervailing duties.

A.I.Ch.E. Metropolitan Student Chapters Hold Conference

New York University was host at a gathering of 200 members of student chapters on March 24–25, with representatives from Columbia University, Pratt Institute, Brooklyn Polytechnic Institute, Cooper Union, College of the City of New York, Newark College of Engineering, Drexel Institute, University of Pennsylvania and Princeton University in attendance. The program of the first day included a visit to the Jacob Ruppert Brewery and a smoker at which there was a talk by Frederick W. Miller, E.I. duPont de Nemours and Co.

A choice of visits to the Hunts Point plant of Consolidated Edison Co. or to Sheffield Farms Co., Inc., was available for the second day. A major event was the student paper contest in which a representative from each of five metropolitan chapters was entered. First prize was awarded to J. M. Seabrook of Princeton, for a well-presented paper on "Applications of Engineering Principles in the Food Industries." Second prize was won by R. B. Griffin of Pratt Institute for his scholarly "Derivation of Rittinger's Law for Very Fine Grinding". Judges of the contest were Gordon MacLean of the Turbo-Mixer Corp., John H. Whitney of the National Lead Co. and R. P. Kite of the Dorr Co.

The meeting was concluded with a banquet at the New York University Faculty Club, at which Erling F. Rosholdt, president of the host chapter, presided. There the students were greeted by Dr. H. J. Masson, chairman of the Department of Chemical Engineering, New York University, Dr. M. C. Molstad of Yale University, chairman of the Institute's committee on student chapters, and Stephen L. Tyler, executive secretary of the Institute. The main address was given by Sidney D. Kirkpatrick, editor of *Chem. & Met.*, and was entitled "Bridging the Gap in Professional Development."

Summer School for Chemical Engineering Teachers

Final arrangements have been made to hold the second summer school for chemical engineering teachers at the Pennsylvania State College during the period of June 21–30, under the auspices of the Society for the Promotion of Engineering Education. The list of topics to be covered and the men in charge are: Thermodynamics, B. F. Dodge; Chemical Kinetics, K. M. Watson; Unit Processes, R. N. Shreve; Teacher Qualifications, A. B. Newman; Service Courses, W. N. Jones; Instrumentation, R. Z. Ragatz; Introductory Calculations, E. L. McMillen; Fluid Flow, J. H. Rushton; Heat Flow, T. B. Drew; Evaporation, W. L. Badger; Laboratory Equipment, H. McCormack; Distillation, G. G. Brown; Drying, R. C. Ernst; Absorption, A. P. Colburn; Extraction, J. C. Elgin; Crystallization, W. R. McCabe; Filtration, H. A. Webber; Classification, etc., L. T. Work; Economics, W. M. Cobleigh; Graphical Calculations, J. H. Koffolt; Chemical Technology, J. R. Withrow; Graduate Programs, F. C. Whitmore; Plant Design, F. C. Vilbrandt; Senior Projects, D. S. Cryder; Comprehensive Problems, O. A. Hougen.

Victor Blast Furnace at Nashville Still Blasting

Victor Chemical Works' blast-furnace plant at Nashville, Tenn., for making phosphoric acid, which was described in *Chem. & Met.* in June, 1933 (pp. 283-7) is still in active, continuous operation. The statement published on page 121 in February, 1939, that this plant had been replaced by the electric furnace installation at Mt. Pleasant, Tenn. was in error. Both plants are now being used for producing non-fertilizer phosphates and will be presented in an early issue of *Chem. & Met.* Pictured Flowsheets.

Problems of Wood Distillation Industry Under Study

First of a series of reports on a study of the problems of the hardwood distallation industry, later to be incorporated and published as a national forest survey, has been issued by the U. S. Forest Service. The first report pays special attention to the timber requirements of the industry, and was prepared by Dr. M. H. Haertel, secretary-treasurer of the Wood Chemical Institute, who is under a temporary appointment as senior conservationist for the Forest Service, engaged in the work of making this survey.

In this report the history of the hardwood distillation industry is sketched and an outline given of the industry's geographical distribution in the United States, employment, processes, raw materials and products. The report also gives data on production, prices, imports exports of charcoal, methanol, acetic acid and acetone, and its relationship with other industries and synthetic production. Figures also are given of the relation of wood consumed to resources and to regrowth, and it is indicated that the industry is not destructive of forest resources. Estimates are given to show the industry will consume within the next few years approximately 600,000 cords of hard wood annually, as compared with an 850,000 cords annually from 1899 to date, 650,000 cords between 1929 and 1937 and 550,000 cords annually since 1929. The industry supplies upward of 90 per cent of the charcoal market, about 22 per cent of the acetic acid and 13 per cent of methanol markets.

Pacific Science Congress Will Open in July

Announcement has been made by the National Research Council that the Sixth Pacific Science Congress will be held in San Francisco and vicinity during the period, July 24 to August 12, 1939, under the ausspices of the Council. The Fifth Congress in this series was held at Victoria and Vancouver, B. C., in 1933, under the auspices of the National Research Council of Canada, and previous congresses have been held at three-year intervals in other countries of the Pacific region.

Sessions of the Sixth Congress will be held at Stanford University and at the University of California at Berkeley, as host institutions on this occasion, and certain public functions and other sessions of the Congress will be held in "Pacific House" on the grounds of the Golden Gate International Exposition through courtesy of the Department of the Pacific Area of the Exposition. The general arrangements for the Congress are in charge of the standing Committee on Pacific Investigations of the National Research Council, of which Doctor Herbert E. Gregory, Director Emeritus of the Bishop Museum in Honolulu is the Chairman. Responsibility for completing the program and for local arrangements is in the hands of a Committee on the Sixth Pacific Science Congress, especially appointed by the Research Council for this purpose, of which Doctor Charles B. Lipman, Dean of the Graduate School of the University of California at Berkeley, is the Chairman.

Varied Program Arranged for Electrochemist's Meeting

Three scientific-technical sessions will make up the greater part of the program which has been arranged for the meeting of The Electrochemical Society to be held in Columbus, April 26-29. The opening session on the morning of April 26 will be devoted to ceramics which is quite appropriate as Columbus is the ceramics center of the country. L. J. Trostel of Baltimore will preside at this session and speakers will include John D. Sullivan, C. L. Norton, Fred A. Harvey, P. C. Kingsbury, Felix Singer, G. W. Heise, and H. Stevens. An invitation has been extended to the members of the American Ceramic Society to attend the session and participate in the discussion on the papers. Luncheon will be in charge of the Theoretical Electrochemistry Division and Prof. George Glockler will discuss "Theoretical Electrochemistry of Gases." The Battelle Memorial Institute has invited the members to visit its laboratories in the afternoon. The schedule for the day also includes a general meeting in the evening at which John H. Thomas of the Owens-Corning Fiberglas Corp. will deliver an address on "The Production of Fiberglas and Glass Diaphragms."

Prof. E. M. Baker will preside at the morning session on April 27 which will be given over to "Electrodeposition and Cells." Papers will be read by W. A. Wesley and J. W. Carey, Charles L. Faust, and Beaumont Thomas, William J. Travers, George A. Moore, Kenneth C. Newman and F. C. Mathers, M. deKay Thompson, J. Baborovsky. The plant of the Owens-Illinois Glass Co., at Newark will be visited in the afternoon and the annual dinner dance will be held in the evening at the Hotel Deshler-Wallick. President Robert L. Baldwin will speak on "Contributions of the Electric Furnace to Modern Welfare."

The Saturday morning meeting will be devoted to "Organic Electro-Products" with Prof. Sherlock Swann in charge. Papers will be presented by C. J. Brockman and J. W. Griffin, Jr., O. W. Brown and Bernard Berkowitz, Dr. Fr. Fichter, Sherlock Swann, Jr., and G. D. Lucker, O. W. Brown and A. E. Brown, W. E. Bradt and A. W. Erickson, S. Glasstone and A. Hickling, Christopher L. Wilson, Alexander Lowy and W. C. Gilbert, H. Jermain Creighton.

Dr. J. W. Marden will give an illustrated talk on "The New Fluorescent Lamp" at the luncheon meeting and this will be followed by a session on "Corrosion of Alloys." Among the speakers will be J. L. Bray and F. R. Morral, F. W. Fink, Gerhard Derge, Colin G. Fink, E. R. Jette, S. Katz, F. J. Schnettler, and M. M. Haring, M. R. Hatfield, and P. P. Zapponi.

Japan Develops Manchukuo Chemical Industry

Special Correspondence

Manchukuo's Five Year Industrial Development Plan, now in its third year, has made satisfactory progress on the whole, though gains in industrial production are not uniformly spread over the entire field.

The spotty development of the scheme is mainly due to the fact that the Tokyo planners were counting heavily on foreign financial and technical assistance, which has failed to materialize up to the moment.

The gains were most pronounced in plan sectors where the Japanese from the outset relied on their own technical ability and financial capacity. The chemical industry of Manchukuo is a case in point. Its productive capacity has increased 400 per cent since the inauguration of the plan two and one-half years ago. This has been achieved solely through injection of Japanese capital and installation of Japanese-built plant.

Japanese investments in Manchukuo's chemical industry in 1938 totalled ¥47,000,000, and this figure is expected to increase this year as positive production expansion drives have started in the ammonium sulphate, soda, salt and pulp industries.

Ten new chemical industrial concerns were incorporated in 1938 with a combined capitalization of ¥26,600,000, while eight companies increased their share capital by a total of ¥20,400,000, making a total business promotion in the chemical field of ¥47,000,000.

The new concerns include: Manchurian Magnesium Co., Toyo Tyre Co., Asia Hide & Leather Co., Manchurian Optical Industry, Kyowa Hide & Leather Co., Manchuria Asano Cement Co., Manchurian Aluminium Co., Hanyo Rubber Co., and Kokka Rubber Co.,

The Manchuria Chemical Manufacturing Co., capitalized at ¥1,000,000, which held its inaugural meeting on December 26 last year, will commence business from May this year. Its plant will be erected at Tungshangchieh, on the Kirin highway. The new firm will manufacture gas masks and similar products for the Manchurian market. The new concern is a subsidiary of the Nippon Chemical Manufacturing Co. and the Showa Chemical Industrial Co.

The Nissan Chemical Co. has decided to incorporate its Chinnampo plant in Manchukuo and will increase its capital to ¥10,000,000.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

LAW MAKING and executive handling of government business important to chemical industry are overshadowed by an unusual combination of domestic politics and international affairs. Normally questions of international relationship are kept out of party politics. Even now the political angle is not represented by a difference between Republicans and Democrats. The difference seems to be, rather, between New Dealers and conservatives.

Some critics of the President even go so far as to say that he is intending to utilize the present international situation as a screen in his effort to reestablish the control of his party. There seems to be no doubt that in many particulars the President has lost his dominance. For the sake of 1940 continuance of New Dealers in office, it is therefore important to cover up the waning prestige while some means is found for reestablishing control.

All this would not have significance for chemical process industry were it not for the fact that the real difference between the conservative and the reform groups is in their attitude toward management of business. Under present circumstances it is a vital consideration, even for technical executives, to note the trend of controls so that they may adequately weigh in their planning the changes which are being attempted and which may be made.

Taxes and Economy

It looked for a brief period as though economy in government might be made a part of the appeasement program of the Administration. That has not developed to be the situation and it does not look as though there were any faction in Washington with any real strength that is sufficiently aggressive with respect to reduced spending to make any important modifications in this direction this year. But movements of this sort are biennials which seldom bloom the first season. It may be judged good politics next year, just before the 1940 Presidential campaign, to vote as well as talk economy in Congress.

There is good evidence early in April that the scheduled increase in social security taxes on wages will be postponed. Otherwise there is no large change in tax levies likely, insofar as they affect the size of the bill to be paid. Whether the form of the corporation tax will be modified is altogether obscured in early April, by the efforts being made by different factions to get the credit for changes which may eventuate. This getting of credit is, in fact, a more important objective at the moment than the making of changes.

Some tax law will have to be passed, but it is not likely to reduce taxes on most business enterprises significantly, even though it may grow into quite an elaborate measure. There may be some reduction in the variety of tax returns required, but that will save comparatively little, if anything, for industry.

Wage and Hour Problems

Apparently the Administration has sponsored a group of amendments proposed for the wage-hour law. Two of these changes probably of greatest importance to process industry are: (1) A proposal to give the Administrator full authority to issue valid regulations and orders, supplanting present advisory opinions, which are binding on no one. (2) A proposal that workers earning $200 or more per month be exempted from over-time requirements of 1½ times normal wages after the prescribed hours per week. Administrator Andrews is known to favor both of these types of changes. But the President, and others close to him, are said to fear any attempt to amend the law this year, lest it grow into an elaborate program of amendments which might greatly weaken the present act.

Reform of the Wagner labor act, which established NLRB, has much less prospect of enactment now than it had at the beginning of the Congressional session. The evils of NLRB are more frankly admitted. But even the thought of opening this act to Congressional debate and change gives every reformer the jitters.

Several other wage regulations directly bearing on process industry have had attention lately. The Department of Labor is actively studying the minimum wages to be fixed in the paper and pulp industry and for fertilizer manufacturers. When so fixed the minimums will govern manufacture whenever Uncle Sam is the buyer of the goods. Since both these industries sell extensively to the government the proceedings have substantial importance to them. Neither industry is dangerously low in its minimums, as considered from the wage-hour law, but both should expect some higher standard than that to be fixed under the Walsh-Healey act.

New Phosphate Furnace

Appropriation is proposed, and seems likely, of nearly a half-million dollars with which TVA might build a fourth phosphate furnace. This would be an "experimental" blast furnace of commercial size intended to try out new methods for making concentrated fertilizers by techniques altogether different than those established at Muscle Shoals in electric furnaces.

It is reliably reported that some of the thoughtful technical men who would have to make this new furnace work are far less enthusiastic about getting this money than are non-technical directors of TVA who still regard cheap fertilizer as important politically, as well as agronomically. The fertilizer industry is much disturbed because they recognize that such a new manufacturing unit would necessarily force the government further into manufacture that would be competitive with privately owned enterprise. They very convincingly show that there is more than abundant manufacturing capacity now in the United States. They are urging Congress, therefore, not to approve this "folly of building the plant at the present time."

It is being suggested also that if this money is given to TVA the President should exercise his executive authority to insist that it be not spent until a very convincing technical report is made as to the merit of such added experimentation on a commercial scale. The question is very pointedly raised as to what TVA could possibly gain from building another furnace when it has not yet undertaken to learn what probably could readily be determined from present blast furnace phosphate units already in existence under private ownership.

The Congressional investigation of TVA was reported April 3. A majority of seven investigators exonerates TVA as an institution, but is definitely critical of A. E. Morgan, former chairman. Most significant for those who wish to continue criticism of the Authority are the recommendations of the minority of three. That Republican group thinks the functions should be divided, with soils and fertilizer going to Agriculture, dam building and power generation to the Engineer Corps, and only power peddling left for TVA.

Strategic Stock Pile

It looks as though Uncle Sam would spend $40 million for stock piles of strategic materials, including not only minerals but also numerous industrial commodities of foreign origin such as rubber, quinine, silk, etc. In large

measure the fundamental principles of stock pile building proposed by an interdepartmental committee last year are preserved. But there are plenty of special modifications that may delay developments in the effort to satisfy domestic producers that nothing will be done contrary to their interests.

Perhaps most important of the constructive features of the law is the proposal that U. S. Geological Survey and Bureau of Mines spent a half million dollars a year between them finding what the domestic reserves of strategic materials, really are and developing potential deposits to the point that they would be actually workable in case of emergency. This 4-year program ought to save Uncle Sam many times the $2 million of cost, if the projects undertaken can be selected without too much attention to political considerations. Close observers feel, however, that the domestic producers who expect these studies to delay purchase of materials from foreign sources are doomed to complete disappointment.

News "Fines"

Identical Bids—Justice Department action charges automobile tire makers under the antitrust law with restricting trade. "Identical bidding, whether or not supported by other evidence, creates a presumption of a combination to fix prices." This is the announced basis of the action stated by Assistant Attorney General Thurman Arnold.

Neutrality—Cash-and-carry neutrality is completely discredited in Washington. But no one seems to have a bright idea as to how the generally expressed desire to keep out of foreign entanglements can be mechanized by new law. There is some danger that Congress may go home leaving the present unsatisfactory act on the books.

Money for TNEC—Behind the scenes it is generally agreed that TNEC will be allowed to drift another year. It will not get the $2 million requested for continuance, but probably will be furnished $600,000. If Leon Henderson is named Douglas' successor, as chairman of SEC, there is little likelihood of any real accomplishment coming from another year of the "anti-monopoly" committee studies. But the staff will still go through the gestures according to schedule.

Government Reorganization — The President will be permitted under the reorganization law as passed by the two Houses to do much shifting about of present agencies. But he will not touch the sacred cows of the legislators, nor can he abolish functions when reorganizing agencies. As a matter of fact if the President now really wants to set up a much more business-like arrangement among government units, he has plenty of chance to do so. But he cannot play politics very effectively as an incidental.

Iodine Production Increased Last Year

The domestic iodine industry, according to the Bureau of Mines, began its second decade under auspicious circumstances. Born in 1928 and threatened with early extinction by progressive reductions in the price of Chilean iodine, it managed in 1938 to increase production, continuing the recovery that started during the preceding year. Imports of crude iodine, all from Chile, dropped sharply to 570,532 lb. valued at $564,302 from the record quantity of 1,967,148 lb. valued at $1,784,491 in 1937. Owing to the importers' policy of maintaining large stocks, these figures disclose nothing as to consumption trends; fluctuations in other years have been almost as violent.

During the year under review, research workers at the University of Wisconsin reported that they had developed a permanent, simple means for stabilizing the iodine content of salt, limestone, minerals, and mineral mixtures. In England the Nitrate Corporation of Chile, Ltd., announced the formation of an Iodine Education Bureau. This Bureau will collect and disseminate scientific information on iodine and will collaborate with scientific institutions in experimental research to extend the knowledge of iodine, with special reference to its use in human and animal nutrition.

A new recovery process owned by the Dow Chemical Co. has been patented recently (U. S. Patent 2,144,119, Jan. 17, 1939). The iodine liberated from brine and removed therefrom by absorption upon activated carbon or charcoal, is precipitated on the anode of an electrolytic cell employing the compressed iodine-charged carbon as cathode.

The Chilean Nitrate and Iodine Sales Corporation reported for the fiscal year ended June 30, 1938 sales of 832,290 kilograms of iodine, which compares with reported totals of 884,965 in 1936-7, 749,335 in 1935-36, and 462,474 in 1934-35.

Gage Laboratory Will Open at Carnegie Tech.

The Ordnance Department of the U. S. Army will establish a gage laboratory at the Carnegie Institute of Technology late this month, thus considerably increasing facilities for research and industry in the Pittsburgh district. The primary purpose of the laboratory is to make available standard measurements of the greatest accuracy for the machines which produce Army equipment. More than $20,000 worth of delicate precision instruments, accurate to the hundred-thousandth and millionth of an inch, will be installed in a laboratory in Industries Hall at Carnegie Tech.

The laboratory will be operated under the general supervision of Dr. Webster N. Jones, director of the College of Engineering, and Major C. H. Morgan, executive officer of the Pittsburgh Ordnance District. Prof. C. C. Leeds of Carnegie will be in charge of the laboratory.

The equipment makes possible measurements within two-millionths of an inch by means of the Van Keuren light wave equipment used to determine the wear on Johanssen precision measuring blocks or diameters of ball bearings and similar measurements where great precision is essential. Another piece of equipment measures length to the hundred-thousandth of an inch. Other apparatus includes a screw thread testing machine, comparators, microscopes, micrometer, surface plates, straight edges, levels, parallels, and squares. All precision equipment has been calibrated at the U. S. Bureau of Standards, and the tabulated calibrations are part of the laboratory records.

In addition to its utilization for government work, the equipment will be available to industries in the Pittsburgh district.

Gray Process Patents Upheld In Texas Suit

In an opinion handed down by Federal Judge James C. Wilson and filed in Amarillo, Texas, on March 24, the clay treating patents of The Gray Processes Corp., were held valid and infringed by the Danciger Oil & Refineries, Inc., at its Pampa, Texas, refinery.

The Gray Process, which has been widely used by the refining industry in the United States and foreign countries, involves the treatment of gasoline produced in cracking, reforming, and other units for the purpose of improving its color and color stability and reducing the gum content. The process comprizes passing the vapors of the oil to be treated through one or more beds of solid adsorptive catalysts, fullers' earth being the material which is most frequently used.

Du Pont Obtains Patents for Separating Minerals

E. I. du Pont de Nemours & Co. was allowed six patents by the U. S. Patent Office on March 21, covering its Sink-and-Float process for the separation of minerals, the most recent invention to emerge from the company's research laboratories. The patents cover the Sink-and-Float process and apparatus as a whole, including a new phenomenon of physical chemistry termed "tough water." Tough water relates to extremely adherent and lasting water films discovered in the course of developing the Sink-and-Float method of separating valuable minerals from worthless material, as, for instance, separating coal from slate. These films are only a few molecules thick, and the peculiar property of toughness of the water, according to the patents, is imparted by film stabilizers which otherwise are known as "active agents," of which starch acetate and tannic acid are examples.

GERMANY CHEMICAL INDUSTRY FEELS SCARCITY OF SKILLED LABOR

From Our German Correspondent

WITH 21 million persons employed in Germany at the beginning of 1939 as against 12 million in 1932, and with the volume of industrial production 146 per cent higher, Germany's economic policies are undergoing constant revision. The chemical industry, as the focal point of the second Four-Year plan, has been unusually affected, although the same conditions prevail in many other industries and even in agriculture. For example, it is estimated that since 1933 at least 400,000 regular agricultural workers have gone to the cities to enter industrial employment in spite of governmental policies aiming to keep them on the land. As a result, the shortage of agricultural labor has been so acute that it has been necessary to import 300,000 agricultural workers, notably from Italy, Poland, Hungary, and Czechoslovakia during the past few years.

With employment at all-time high levels, the shortage of skilled and unskilled labor has become serious. Last November only 152,000 persons in the Reich were recorded as unemployed, and many of these were simply unemployables. The use of lower marginal labor and optimum machine capacity has cut down plant efficiency and increased depreciation of machinery in many cases. The acute shortage of skilled labor is reflected in the pages of help wanted advertisements appearing in newspapers as well as in trade journals. Large firms are seeking trained chemists, engineers, draughtsmen, etc., as the supply of technical institutes and universities has become inadequate.

Difficulty in finding people to fill newly created positions in Germany's expanding chemical industry is reflected in an article in the January issue of "Die Chemische Industrie" by Dr. Claus Ungewitter, head of the German industrial chemical association. He states that the minimum present and future needs of the industry call for an immediate doubling of the number of trained men turned out by the technical institutes. A step to speed up this process was a decree of Dec. 14, 1938, of the Minister of Education, cutting down the course of study in technical institutes to three years. The same decree provides that 30 per cent of the most talented and needy students in the technical institutes be given free tuition.

Early Nazi policy tried to take women out of industry and put them back into the home. Now women are being encouraged to study for work in laboratories, draughting rooms, etc., and last year 31 per cent of all persons employed were women, which is approximately the same percentage as in 1929. The number of women students in technical institutes is still small: whereas there were 3,300 women students of medicine in 1938, there were only 52 specializing as "Technicker" in chemistry and engineering. Evidence of the reversed trend was the recent appointment of the first woman as full professor in the Third Reich, and interestingly enough, in chemistry. At present there are in addition, 37 women associate and assistant professors and instructors at German universities and technical institutes, several of them in chemistry.

The subject of "rationalization" in industry has also seen a reversal in official attitude and is widely discussed in Germany today. "Rationalization" once tabooed as an idea promoted by selffish liberalistic, capitalistic employers who cared only about profits and nothing about the human needs of employees, is now being polished up to look attractive.

Various methods of solving these problems are being tried. One, already indicated, is to cut down study time so that in spite of army and labor service, workers will be available for certain industries at younger ages. At the other end of the scale, more older people are being retained and re-employed, and instead of lowering retirement ages as in the past few years, in some fields they are being raised. Women are also being used increasingly, but only to perform tasks for which they are physically fitted. Working time has been boosted in some industries, although the average for all industries is still only 8½ hours per day.

Because of low world raw material prices and other factors, in 1938 production in German industries was not as hampered by raw material shortages as heretofore. The search for new raw materials continues unabated, however, and the latest source being considered is coal ash. With a yearly hard coal output in Germany of 200 million tons, Dr. Ungewitter estimates that with an ash content of 5 per cent—which is low—10 million tons of coal ashes would be available annually. If only a quarter of this, or 2.5 million tons, were available for processing, German chemists estimate that they could recover enough metals to justifying processing economically. The average ton of coal ash in Germany, they compute, contains 2.7 kg. of steel alloy materials (cobalt, nickel, molybdenum, chromium, vanadium worth 35 RM, 19 kg. of nonferrous metals (tin, zinc, lead, arsenic) worth 4 RM, 6 grams of precious metals (gold, platinum, palladium, silver) worth 3 RM, and rare metals (beryllium, gallium, lanthanum) worth 60 RM.

Production of synthetic textile fibers, chiefly from domestic raw materials is also going ahead rapidly. Rayon production rose from 28,000 metric tons in 1932 to 65,000 tons in 1938. A new plant using the latest developed processes is the Rheinische Kunstseide A.G. in Krefel, which will take up full production by the middle of 1939. Staple fiber production has risen still more sharply than rayon, from 2,000 tons in 1932 to a yearly capacity of 225,000 tons, which is expected to be reached also by the middle of this year. In addition to the two oldest concerns, I.G. Farben and Vereinigte Glanzstoff, seven regional "cell wool" factories have been established with an outlay of 225 million RM, each operating under its own initiative and its own industrial ideas. Again, their difficulty has been not so much in the financing as in the difficulty of finding suitable chemists and engineers.

In the Sudetic and Austrian areas instead of reopening old shut down textile plants on their old production schedules, the Germans are equipping them to produce staple fiber according to the latest processes, since they are all located in forest areas with cellulose available readily. The staple fiber has been developed now to the point where it has largely overcome the initial difficulties arising from the fact that it was not as strong as the natural fibers when wet.

Government Chemists Develop New Use for Lactic Acid

Scientists of the U. S. Bureau of Dairy Industry have perfected a process for making a transparent rubber-like substance from lactic acid of whey that has promising uses in various industrial operations. Known as polymethylacrylate, the water-white semi-solid material is closely related to the so-called organic glass made synthetically and used for highway reflectors. It is said to be softer and more flexible than organic glass, however, but is very tough and elastic.

Laboratory results obtained by Lee T. Smith and H. V. Claborn, chemists in the Bureau's Division of Dairy Research Laboratories, indicate that polymethylacrylate can be produced as cheaply from lactic acid by their method as it is now produced from ethylene or alcohol by the cyanhydrin process. The Bureau scientists believe the cheapness of their process will contribute to the increased use of lactic acid.

Hercules Will Build New Synthetic Ammonia Unit

Plans have been completed by Hercules Powder Co., for the erection of a synthetic ammonia unit at its industrial explosives plant at Hercules, Calif. This operation will take care of the plant's requirements of ammonia in the production of nitric acid and ammonium nitrate. The new plant is expected to go into operation by the first of next year.

PERSONALITIES

Charles A. Higgins

✦ CHARLES A. HIGGINS was elected president of Hercules Powder Co. at the meeting of the Board of Directors at Wilmington, Del., on March 22. The new president has been with Hercules since 1915 and has been vice chairman of the executive committee since 1933. He succeeds R. H. Dunham, who continues with the company as chairman of the board of directors, the position he held jointly with the presidency since the organization of the company.

✦ CLEMENT A. BARRERE has resigned as manager of the Bradford Oil Refining Co., Bradford, Pa., to join the Lummus Co. as process and sales engineer. Prior to his association with Bradford he was in charge of lubricating oils for Phillips Petroleum Co. and the Texas-Pacific Coal and Oil Co. He is a native of New Orleans and a graduate chemical engineer from Louisiana State University.

✦ M. A. WILLIAMSON, publisher of *Chem. & Met.* and vice-president of the McGraw-Hill Publishing Co., has been elected to the board of directors of the company.

✦ JOHN J. CROWE, research engineer for Air Reduction Sales Co., received the 1937 James Turner Morehead Medal, sponsored by the International Acetylene Association. This medal is awarded annually for outstanding work in the production or utilization of calcium carbide and acetylene.

✦ ROBERT E. ADAMS and W. G. N. Heer have been added to the research staff of Battelle Memorial Institute, Columbus, Ohio. Mr. Adams is a recent graduate of the University of Wisconsin. Mr. Heer is a graduate of the University of Alabama and was previously associated with the Tennessee Coal, Iron and Railroad Co.

✦ JOSEPH SURCHEK, who graduated from the University of Chicago in 1935, has become associated with the Dearborn Chemical Co., Chicago.

✦ HARRY G. THODE has joined the research department of the U. S. Rubber Co., Passaic, N. J.

✦ H. M. SELL, who received his Ph.D. degree from the University of Wisconsin in 1938, has accepted a position at the Tung Oil Laboratory of the U. S. Department of Agriculture at Gainesville, Fla.

✦ R. M. AUDE, a recent graduate of the chemical engineering department of the University of Wisconsin, is now employed by the Monsanto Chemical Co.

✦ WAYNE GITCHELL is now located with the Heresite & Chemical Co., Manitowoc, Wis.

✦ RICHARD DEHONEY, formerly with the Henry Vogt Co., has accepted a position with the Lummus Co., New York, N. Y.

✦ HARRIS RUME, formerly with J. E. Seagrams & Sons, is connected with the Spur Oil Co., Nashville, Tenn.

✦ DONALD L. HAGUE has resigned his position with the Dorr Co. and has become associated with Fuller & Smith & Ross.

✦ CHARLES F. VAUGHN of the Mathieson Alkali Works has been awarded the Jacob F. Schoellkopf Medal for 1939 by the Western New York Section of the A. C. S.

Norman W. Krase

✦ NORMAN W. KRASE, who has been head of chemical engineering at the University of Pennsylvania since 1936, has resigned effective July 1, 1939, to accept a position with E. I. du Pont de Nemours & Co., Inc. He will be in charge of semi-works development for the ammonia department in Wilmington.

OBITUARY

✦ ARTHUR E. HILL, professor of chemistry at the College of Arts and Pure Science of New York University and head of the University's graduate school of the chemical department, died March 15 of pneumonia at his home in New York City. He had been ill for a month.

✦ FREDERICK J. KENNEY died February 23 at Daytona Beach, Fla., of a heart ailment at the age of 60 years. He served as a chemist for 41 years in various New York City departments, retiring in 1935 as chief chemist of the central testing laboratory of the Department of Purchase. He was born in New York, and studied at Columbia University before entering the services of the City in 1894.

✦ ELAN C. CURTIS, assistant general superintendent of the Niagara Falls plant of the Mathieson Alkali Works, died on Feb. 18, 1939. He was 45 years of age.

CALENDAR

APRIL 16-21, AMERICAN CERAMIC SOCIETY, Hotel Stevens, Chicago, Ill.
APRIL 26-29, ELECTROCHEMICAL SOCIETY, spring meeting, Deshler-Wallick Hotel, Columbus, Ohio.
MAY 15-17, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Akron, Ohio.
JUNE 18-22, AMERICAN ELECTROPLATERS' SOCIETY, international convention, Asbury Park, N. J.
JUNE 26-30, AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J.
SEPT. 11-15, AMERICAN CHEMICAL SOCIETY, fall meeting, Boston, Mass.
SEPT. 12-14, TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, fall meeting, Hotel Syracuse, Syracuse, N. Y.
DEC. 4-9, CHEMICAL EXPOSITION, Grand Central Palace, New York City.

Chemical ECONOMICS and MARKETS

CONSUMPTION OF CHEMICALS MADE APPRECIABLE GAIN IN RECENT WEEKS

ALTHOUGH some of the large manufacturing industries reported spotty conditions throughout March and some of the indexes for business for that month were lowered, the tenor of business was upward for most of the industries which are large consumers of chemicals. Favorable reports came from the pulp and paper, glass, plastics, paint and varnish, rayon, textile, leather, and rubber trades. *Chem. & Met.'s* preliminary index for chemical consumption for March was in excess of 117 which is the highest point reached since October, 1937. This compares with an index of 109.88 for February and a revised number of 114.97 for January.

From the data now at hand, it is possible to make a fairly close comparison for the first quarter of this year with the like period of last year. It is of interest to note that there were wide differences in the rate of gain as applied to the individual chemicals. For instance, the monthly indexes would indicate that consumption of sulphuric acid—the chemical of largest tonnage movement—for the first three months of this year was approximately 1,780,000 tons expressed in terms of 50 deg. Bé or about 10 per cent more than the amount consumed in the first quarter of 1938. In the same way the use of soda ash—the second ranking chemical—appears to have been about 510,000 tons in the Jan-March period of this year as against 430,000 tons for the comparable period of 1938, or a gain of more than 18 per cent.

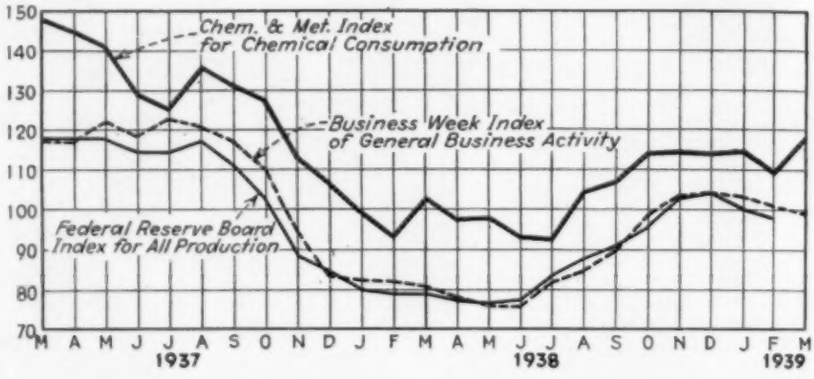
***Chem. & Met.* Index for Consumption of Chemicals**

	January (Revised)	February
Fertilizer	25.47	24.45
Pulp and paper	15.20	15.35
Glass	10.46	9.60
Petroleum refining	13.00	11.53
Paint and varnish	8.17	8.25
Iron and steel	6.93	6.54
Rayon	8.62	8.30
Textiles	7.58	7.13
Coal products	6.83	6.23
Leather, glue and gelatine	4.13	4.48
Explosives	4.27	3.88
Rubber	2.56	2.38
Plastics	1.74	1.76
	114.97	109.88

Unsettled conditions abroad and the adverse action of the stock market undoubtedly had considerable influence on the course of business but from a chemical standpoint at least, the effect was merely to restrict the per cent of increase. The immediate prospect for the industries which affect chemical manufacture is encouraging and second quarter operations should make further gains.

The price movement for chemicals in recent months has been downward but an analysis of the commodities for which lower prices have become effective reveals that weakness has been confined to certain groups and that the major part of chemical output is maintaining a steady price position so that the drop in the average price level can scarcely be construed as evidence of a falling off in consumption. With few exceptions inventories of chemicals are reported as normal and where selling pressure has been keenest it seems to have resulted from attempts to increase production to a point beyond current consumption possibilities.

According to the estimate of the shippers advisory boards, there will be an increase of 12.6 per cent in the volume of freight shipped in the second quarter of this year as compared with the movement in the second quarter of last year. Increases are anticipated for all but eight of the commodity groups. The largest gain is expected in shipments of ore concentrates with an increase of 72.4 per cent and the sharpest decrease applies to cotton which is expected to drop 22.5 per cent below the total for the second quarter of 1938. Expected gains in shipments for some of the commodity groups are: salt, 5.9 per cent; petroleum and products, 2.9 per cent; sugar, syrup, and molasses, 4.1 per cent; iron and steel, 45 per cent; lime and plaster, 14.4 per cent; automobiles, trucks and parts, 59.4 per cent; paper and paperboard, 10.9 per cent; chemicals and explosives, 12.2 per cent. Among the groups for which declines are anticipated is fertilizer with a drop of 1.3 per cent. Incidentally, the American Trucking Ass'n. reports that the movement of goods by trucks in February was 25.7 per cent higher than that for February last year.

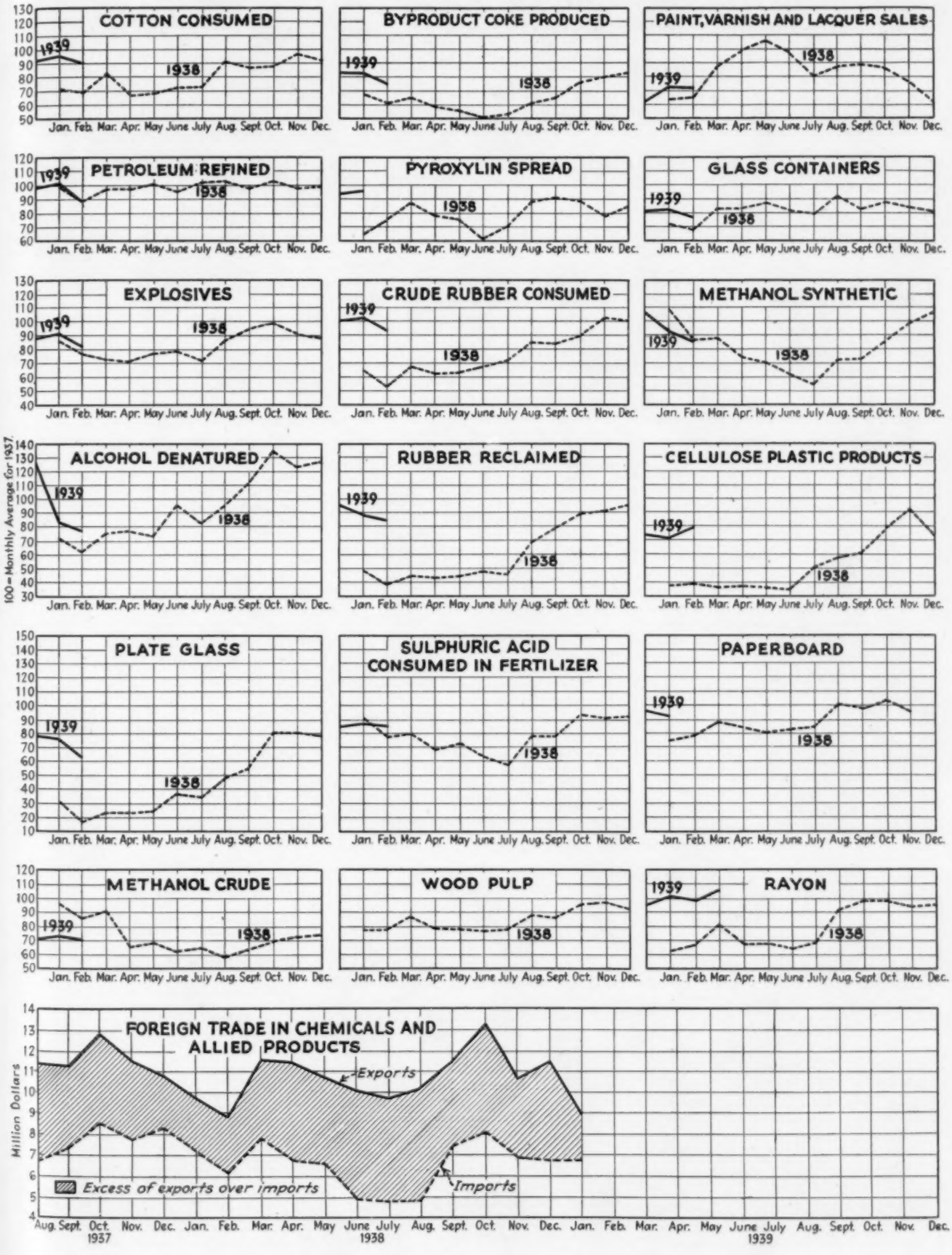


Production and Consumption Data for Chemical-Consuming Industries

	Feb. 1939	Feb. 1938	Jan.–Feb. 1939	Jan.–Feb. 1938	Per cent of gain for 1939
Production					
Alcohol, ethyl, 1000 pr. gal	14,671	16,765	31,738	32,372	1.9*
Alcohol, denatured, 1000 wi. gal	6,454	5,088	13,282	10,971	21.1
Ammonia, liquor 1000 lb	3,973	3,371	8,237	7,026	17.2
Ammonium sulphate, 1000 lb	83,560	66,963	175,073	142,432	22.9
Benzol, 1000 gal	7,141	5,575	14,924	11,730	27.2
Byproduct coke, 1000 tons	3,078	2,494	6,445	5,256	22.6
Glass containers, 1000 gr	3,389	2,995	6,978	6,120	14.0
Plate glass, 1000 sq. ft	10,165	2,664	22,374	7,783	187.5
Cellulose acetate plastics 1000 lb	989	338	1,885	683	176.0
Nitrocellulose plastics, 1000 lb	1,049	675	1,972	1,321	49.3
Rubber reclaimed tons	13,093	6,012	26,856	13,479	91.8
Consumption					
Cotton, bales	562,293	426,866	1,154,284	860,124	34.2
Silk, bales	33,219	30,260	74,035	60,975	21.4
Wool, 1000 lb	31,225	16,072	66,950	32,453	106.3
Automobiles, factory sales	297,841	186,531	637,033	396,059	60.8
Rubber, crude, tons	42,365	23,868	88,599	53,297	66.2
Waste paper, tons	247,710	215,047	481,021	418,471	14.9

* Per cent of decline.

Production and Consumption Trends



DOWNWARD PRICE TREND CONTINUES IN MARKET FOR VARIOUS SOLVENTS

WHILE demand for chemicals has continued to run considerably ahead of the rate in effect a year ago, there has been a lag in certain directions which has prevented uniform progress. In fact, the market of late has been featured by reports of wide differences in the rate of activity in different branches of the industry. For instance, call for some of the chemical pigments in the last month has been very active and in the case of titanium salts a new high record may have been established for March sales. Fertilizer chemicals have fallen below the sales standards of last year and insecticides and other agricultural chemicals, while attracting more interest have not sold up to expectations. Considering the large output of automobiles and the rise in building in recent months, there has not been a comparable pick-up in demand for chemicals on the part of glass manufacturers. The textile and leather trades have been buying steadily and some branches of the paper trade have kept their chemical requirements on a high plane.

Prices for the more important heavy chemicals with the exception of chlorine have been steady and the competition in chlorine seems to have run its course as far as reductions in value are concerned. Solvents, however, are still under pressure. Price declines were almost general in the last month. They included not only ethyl and butyl alcohol but also such items as acetaldehyde, paraldehyde, aldol, crotonaldehyde, vinyl acetate, paraldol, and acetamide. Spirits of turpentine was firmly held for the greater part of the period and the market appeared to have been steadied by the report that the naval stores loan plan had been approved. In fact, sales schedules for both turpentine and rosin had held at advances over those for the preceding month but the quotations were largely nominal and early in April a drop of more than four cents a gallon was registered for turpentine in a single day in the Savannah market.

Prices for vegetable oils and animal fats also were lower with the paint-making oils showing resistance to the general trend but in the case of China wood oil, firmness was due to the rise at primary points rather than to any increase in domestic buying.

Reports current in the market indicate that stocks of glycerine are firmly held. This is rather surprising in view of the sharp break in price in the English market early last month. Demand for glycerine has not been active in recent months and in addition to the lower rate of industrial activity last year, glycerine was reported to have lost ground in some fields due to the greater use of competitive materials. For instance, the closure trade is said to have turned to substitute materials to a considerable extent. Nitrate of ammonia also is said to have cut in heavily in competition with nitroglycerine in the explosives trade. Furthermore, stocks of glycerine at the beginning of the year amounted to 83,074,201 lb., divided, 13,410,421 lb. crude; 22,170,245 lb. dynamite; and 47,593,535 lb. C. P. Stocks at the beginning of 1938 amounted to 50,770,766 lb., so there was considerable accumulation during the last year. Imports of refined fell off sharply last year but there was only a moderate drop in the inward movement of crude.

Notwithstanding the recession in business last year, production of bromine, as reported by producers to the Bureau of Mines, continued to increase by leaps and bounds as it has in every year since 1932. The 1938 output was 16,760 short tons valued at $6,651,000 compared with 13,100 tons worth $5,180,177 in 1937 and 10,305 tons valued at $4,038,438 in 1936. Not until 1923 did bromine begin to be used in the form of ethylene dibromide for making tetraethyl lead compounds for antiknock motor fuels and as recently as 1925 the output was only 783 tons. The latest statistics, therefore, reveal an increase of almost 2,000 per cent in 13 years. Even during the last three years the output of bromine has virtually doubled. Domestic demand for all kinds of motor fuel also has increased but the gain was only from 434,810,000 bbl. in 1935 to 521,657,000 in 1938, roughly 20 per cent instead of 100 per cent for the three year period. In the late 1920's the rate of increase in gasoline demand was about 20 per cent a year, but it slowed down until in 1932 there was a slight recession. Although the uptrend was resumed later the advance in 1938 over the previous year was barely perceptible whereas the advance in bromine requirements was 28 per cent.

The average value of the output of domestic bromine in 1938, as reported to the Bureau of Mines by producers, was a trifle less than 20c. a lb. f.o.b. plant or shipping point, almost exactly the same as in 1937.

In view of the announcement of the Department of Commerce that imports of chemicals and related products from Germany declined sharply last year, the recent imposition of compensatory duties on imports from that country would indicate that this trend might be expected to continue.

Imports of chemicals and related products from Germany last year were valued at $18,642,000 compared with $27,226,000 in 1937 and $20,095,000 in 1936. Fertilizer materials and coal-tar products each accounted for one-third of the total trade. Imports of fertilizers of German origin were valued at $6,314,000 compared with $12,378,000 in 1937, a decrease of approximately 50 per cent, while the volume decreased about 60 per cent, or from 476,235 long tons to 196,033 long tons. Imports of coal-tar products advanced slightly to a total value of $6,698,000 from $6,167,000 during the preceding year.

Other leading chemical import items making up the list include sodium compounds, receipts of which decreased in value from $3,336,000 in 1937 to $1,725,000 in 1938. In this classification receipts of sodium sulphate decreased from 162,976 tons to 93,406 tons and sodium cyanide from 9,085 tons to 5,567 tons. Imports of potassium compounds, however, chiefly potassium chlorate, advanced slightly to a total value of $921,000 from $903,000 in 1937.

Other imports of chemicals and related product items of German origin, receipts of which were smaller last year compared with 1937, included medicinal and pharmaceutical preparations, imports of which decreased in value from $1,055,000 to $1,053,000; ammonium chloride, from $124,000 to $110,000; synthetic camphor, from $643,000 to $207,000; cobalt oxide, from $345,000 to $203,000; and glycerine, from $189,000 to $1,000, according to the Chemical Division.

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base=100 for 1937

This month	**97.48**
Last month	97.95
April, 1938	100.22
April, 1937	100.17

Price changes were all in favor of the down side with most of the solvents offered at reduced levels. Chlorine was quotably unchanged but none too strong and small lot buyers of some chemicals have found lower differentials from the round lot figure.

CHEM. & MET.

Weighted Index of Prices for

OILS AND FATS

Base=100 for 1937

This month	**68.25**
Last month	70.83
April, 1938	77.28
April, 1937	117.85

The price trend still is downward. Crude cottonseed oil led in the decline which affected values for peanut, soybean, and coconut oils. China wood oil, affected by conditions in primary markets, was an exception to the general trend with higher asking prices in effect.

Current PRICES

INDUSTRIAL CHEMICALS

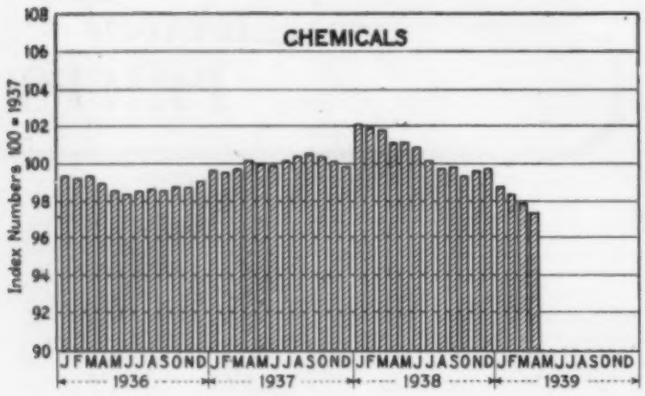
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.05½–$0.06½	$0.05½–$0.06½	$0.05½–$0.06½
Acid, acetic, 28%, bbl., cwt.	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	105.00–115.00
Citric, kegs, lb.	.21½– .24	.22½– .25	.24 – .27
Formic, bbl., ton	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb.	.70 – .75	.70 – .75	.75 – .78
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriatic, 18°, tanks, cwt.	1.05 –.....	1.05 –.....	1.05 –.....
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –.....	18.50 –20.00
Oxalic, crystals, bbl., lb.	.10¾– .12	.10¾– .12	.10¾– .12
Phosphoric, tech., c'bys., lb.	.07½– .08½	.07½– .08½	.09 – .10
Sulphuric, 60° tanks, ton	13.00 –.....	13.00 –.....	13.00 –.....
Sulphuric, 66°, tanks, ton	16.50 –.....	16.50 –.....	16.50 –.....
Tannic, tech., bbl., lb.	.40 – .45	.40 – .45	.40 – .45
Tartaric, powd., bbl., lb.	.27½–.....	.27½–.....	.25½–.....
Tungstic, bbl., lb.	2.35 –.....	2.35 –.....	2.75 –.....
Alcohol, Amyl	.....	.....	.....
From Pentane, tanks, lb.	.101–.....	.101–.....	.123–.....
Alcohol, Butyl, tanks, lb.	.07½–.....	.08 –.....	.08½–.....
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.54 –.....	4.54 –.....	4.14 –.....
Denatured, 190 proof	.....	.....	.....
No. 1 special, dr., gal. wks.	.26½–.....	.28 –.....	.34 –.....
Alum, ammonia, lump, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Potash, lump, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Aluminum sulphate, com. bags, cwt.	1.15 – 1.40	1.15 – 1.40	1.35 – 1.50
Iron free, bg., cwt.	1.30 – 1.55	1.30 – 1.55	2.00 – 2.25
Aqua ammonia, 26°, drums, lb.	.02 – .03	.02 – .03	.02½– .03
tanks, lb.	.02 – .02½	.02 – .02½	.02½– .02½
Ammonia, anhydrous, cyl., lb.	.15½–.....	.15½–.....	.15½–.16
tanks, lb.	.04½–.....	.04½–.....	.04½–.16
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks, cwt.	1.40 –.....	1.40 –.....	1.475–.....
Amylacetate tech., tanks, lb.	.9½–.....	.09½–.....	.11 –.....
Antimony Oxide, bbl., lb.	.11 – .12	.11 – .12	.12½– .13
Arsenic, white, powd., bbl., lb.	.03 – .03¼	.03 – .03¼	.03 – .03¼
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb.	.07 – .08	.07 – .08	.07 – .08
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f. o. b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	48.00 –51.00	48.00 –51.00	46.00 –51.00
Bromine, cs., lb.	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.65 –.....	1.65 –.....	1.65 –.....
Arsenate, dr., lb.	.06¼– .07	.06¼– .07	.06¼– .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	21.50 –24.50	21.50 –24.50	21.50 –24.50
flake, dr., del., ton	23.00 –25.00	23.00 –25.00	23.00 –25.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb.	.04½– .05½	.04½– .05½	.05½– .06
Chlorine, liquid, tanks, wks., lb.	1.75 –.....	1.75 –.....	2.15 –.....
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.67 – 1.70	1.67 – 1.70	1.67 – 1.70
Copperas, bgs., f. o. b., wks., ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Copper carbonate, bbl., lb.	.10 – .16½	.10 – .16½	.09 – .16
Sulphate, bbl., cwt	4.35 – 4.60	4.50 – 4.75	4.25 – 4.50
Cream of tartar, bbl., lb.	.22½– .23	.22½– .23	.20½– .21
Diethylene glycol, dr., lb.	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb.	.061–.....	.061–.....	.06½–.....
Formaldehyde, 40%, bbl., lb.	.05½– .06½	.05½– .06½	.05½– .6½
Furfural, dr., lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.12½– .14	.12½– .14	.12½– .14
Glaubers salt, bags, cwt.	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb.	.12½–.....	.12½–.....	.15½–.....
Lead:			
White, basic carbonate, dry casks, lb.	.07 –.....	.07 –.....	.06½–.....
White, basic sulphate, sck., lb.	.06½–.....	.06½–.....	.05½–.....
Red, dry, sck., lb.	.0735–.....	.0735–.....	.07 –.....
Lead acetate, white crys., bbl., lb.	.10 – .11	.10 – .11	.11 – .12
Lead arsenate, powd., bbl., lb.	.11 – .11½	.11 – .11½	.13 – .13½
Lime, chem., bulk, ton	8.50 –.....	8.50 –.....	8.50 –.....
Litharge, pwd., csk., lb.	.0635–.....	.0635–.....	.06 –.....
Lithophone, bags, lb.	.04½– .04¾	.04½– .04¾	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal.	.31 –.....	.31 –.....	.31 –.....
97%, tanks, gal.	.32 –.....	.32 –.....	.32 –.....
Synthetic, tanks, gal.	.33 –.....	.33 –.....	.33 –.....
Nickel salt, double, bbl., lb.	.13 – .13½	.13 – .13½	.13 – .13½
Orange mineral, csk., lb.	.10½–.....	.10½–.....	.10 –.....
Phosphorus, red, cases, lb.	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb.	.18 – .25	.18 – .25	.24 – .30
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.08½– .09
Carbonate, 80–85%, calc. csk., lb.	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb.	.09½–.....	.09½–.....	.09½–.....
Hydroxide (c'stic potash) dr., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bgs., unit.	.53½–.....	.53½–.....	.53½–.....
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussate, yellow, csks, lb.	.14 – .15	.14 – .15	.15 – .16
Sal ammoniac, white, casks, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	.105 –.....	1.05 –.....	1.05 –.....
Dense, bags, cwt.	1.10 –.....	1.10 –.....	1.10 –.....
Soda, caustic, 76%, solid, drums, cwt.	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb.	.04 – .05	.04 – .05	.04½– .05
Bicarbonate, bbl., cwt.	1.70 – 2.00	1.70 – 2.00	1.75 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.06½– .07
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Chlorate, kegs, lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Cyanide, cases, dom., lb.	.14 – .15	.14 – .15	.16½– .17
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.20 – 3.20	2.20 – 3.20	2.15 – 3.15
Nitrate, bags, cwt.	1.45 –.....	1.45 –.....	1.45 –.....
Nitrite, casks, lb.	.06½– .07	.06½– .07	.07 – .08
Phosphate, dibasic, bags, lb.	1.85 –.....	1.85 –.....	1.85 – .024
Prussiate, yel. drums, lb.	.09½– .10	.09½– .10	.10 – .11
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, crys., bbl., lb.	.02½– .02¾	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton	16.00 –.....	16.00 –.....	18.00 –.....
Chloride, dr., lb.	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb.	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.50 –.....	.50 –.....	.46 –.....
Crystals, bbl., lb.	.36 –.....	.36 –.....	.32½–.....
Zinc, chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb.	.33 – .35	.33 – .35	.36 – .38
Dust, bbl., lb.	.06½–.....	.06½–.....	.06½–.....
Zinc oxide, lead free, bag., lb.	.06½–.....	.06½–.....	.06½–.....
5% lead sulphate, bags, lb.	.06½–.....	.06½–.....	.06½–.....
Sulphate, bbl., cwt.	2.75 – 3.00	2.75 – 3.00	3.15 – 3.60

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 13

OILS AND FATS

	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb.	$0.08½–$0.10	$0.08½–$0.10	$0.09½–$0.10
Chinawood oil, bbl., lb.	.15½–.....	.15 –.....	.15 –.....
Coconut oil, Ceylon, tank, N. Y., lb.	.03¼–.....	.03¼–.....	.03¼–.....
Corn oil crude, tanks (f. o. b. mill), lb.	.05½–.....	.06½–.....	.07½–.....
Cottonseed oil, crude (f. o. b. mill), tanks, lb.	.05½–.....	.05½–.....	.07 –.....
Linseed oil, raw car lots, bbl., lb.	.080–.....	.088–.....	.093–.....
Palm, casks, lb.	.03¾–.....	.03¾–.....	.04 –.....
Peanut oil, crude, tanks (mill), lb.	.05½–.....	.06¼–.....	.07½–.....
Rapeseed oil, refined, bbl., gal.	.80 –.....	.80 –.....	.88 –.....
Soya bean, tank, lb.	.04½–.....	.05½–.....	.06 –.....
Sulphur (olive foots), bbl., lb.	.06½–.....	.07 –.....	.08½–.....
Cod, Newfoundland, bbl., gal.	.32 –.....	.38 –.....	.52 –.....
Menhaden, light pressed, bbl., lb.	.066–.....	.07 –.....	.087–.....
Crude, tanks (f. o. b. factory), gal.	.30 –.....	.30 –.....	.35 –.....
Grease, yellow, loose, lb.	.05 –.....	.04½–.....	.04½–.....
Oleo stearine, lb.	.06½–.....	.06½–.....	.07½–.....
Oleo oil, No. 1	.07½–.....	.07½–.....	.08½–.....
Red oil, distilled, d.p. bbl., lb.	.07½–.....	.07½–.....	.09½–.....
Tallow extra, loose, lb.	.05½–.....	.05½–.....	.05½–.....

Chem. & Met.'s Weighted Price Indexes


CHEMICALS
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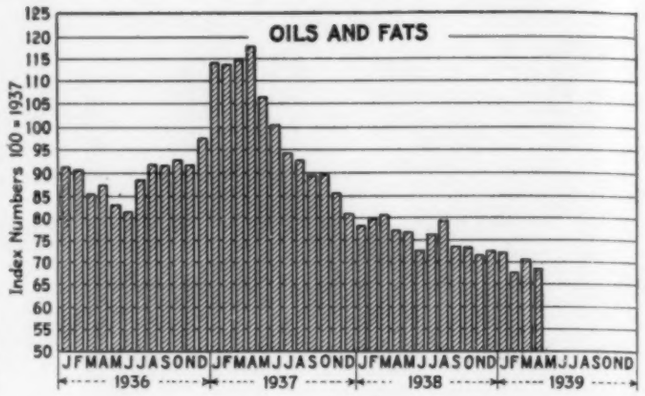

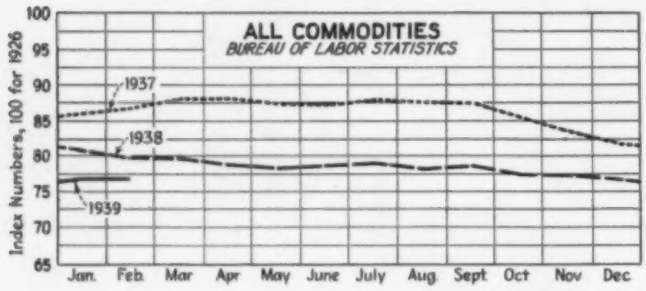

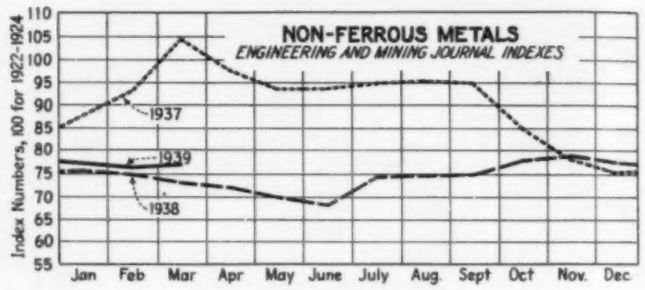

COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb	$0.52 –$0.55	$0.52 –$0.55	$0.52 –$0.55
Alpha-naphthylamine, bbl., lb	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb	.15 – .16	.15 – .16	.15 – .16
Aniline, salts, bbl., lb	.22 – .24	.22 – .24	.22 – .24
Benzaldehyde, U.S.P., dr., lb	.85 – .95	.85 – .95	.85 – .95
Benzidine base, bbl., lb	.70 – .75	.70 – .75	.70 – .75
Benzoic acid, U.S.P., kgs., lb	.54 – .56	.54 – .56	.52 – .54
Benzyl chloride, tech., dr., lb	.23 – .25	.23 – .25	.25 – .27
Benzol, 90%, tanks, works, gal	.16 – .18	.16 – .18	.16 – .18
Beta-napthol, tech., drums, lb	.23 – .24	.23 – .24	.23 – .24
Cresol, U.S.P., dr., lb	.10 – .11	.10 – .11	.12 – .13
Cresylic acid, dr., wks., gal	.69 – .71	.69 – .71	.89 – .92
Diethylaniline, dr., lb	.40 – .45	.40 – .45	.40 – .45
Dinitrophenol, bbl., lb	.23 – .25	.23 – .25	.23 – .25
Dinitrotoluen, bbl., lb	.15 – .16	.15 – .16	.15 – .16
Dip oil, 15%, dr., gal	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb	.32 – .36	.32 – .36	.32 – .36
H-acid, bbl., lb	.50 – .55	.50 – .55	.50 – .55
Naphthalene, flake, bbl., lb	.05½– .06	.05½– .06	.06½– .07
Nitrobenzene, dr., lb	.08 – .09	.08 – .09	.08 – .09
Para-nitraniline, bbl., lb	.47 – .49	.47 – .49	.50 – .52
Phenol, U.S.P., drums, lb	.14½–.....	.14½–.....	.14½–.....
Picric acid, bbl., lb	.35 – .40	.35 – .40	.35 – .40
Pyridine, dr., gal	1.55 – 1.60	1.55 – 1.60	1.55 – 1.60
Resorcinal, tech., kegs, lb	.75 – .80	.75 – .80	.75 – .80
Salicylic acid, tech., bbl., lb	.33 – .40	.33 – .40	.34 – .40
Solvent naptha, w.w., tanks, gal	.26 –.....	.26 –.....	.30 –.....
Tolidine, bbl., lb	.86 – .88	.86 – .88	.88 – .90
Toluene, tanks, works, gal	.27 –.....	.27 –.....	.35 –.....
Xylene, com, tanks, gal	.26 –.....	.26 –.....	.35 –.....

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb	.07½– .11	.07½– .11	.07 – .12
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors			
Carbon gas, black (wks.), lb	.02½– .30	.02½– .30	.02½– .30
Prussian blue, bbl., lb	.36 – .37	.36 – .37	.36 – .37
Ultramarine blue, bbl., lb	.10 – .26	.10 – .26	.10 – .26
Chrome green, bbl., lb	.21 – .30	.21 – .30	.21 – .27
Carmine red, tins, lb	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb	1.57 – 1.58	1.58 – 1.60	1.45 – 1.50
Chrome yellow, C.P., bbl., lb	.14½– .15½	.14½– .15½	.14½– .15½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb	.06 – .06½	.06 – .06½	.06 – .06½
Gum copal Congo, bags, lb	.06 – .30	.06 – .30	.08 – .30
Manila, bags, lb	.07 – .14	.07 – .14	.09 – .14
Damar, Batavia, cases, lb	.16 – .24	.16 – .24	.16 – .24
Kauri cases, lb	.17½– .60	.17½– .60	.18½– .60
Kieselguhr (f.o.b. N. Y.), ton	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	50.00 –.....	50.00 –.....	50.00 –.....
Pumice stone, lump, bbl., lb	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb	.03 – .04	.03 – .04	.03 – .04
Rosin, H., bbl	6.20 –.....	7.00 –.....	6.10 –.....
Turpentine, gal	.30½–.....	.34 –.....	.28½–.....
Shellac, orange, fine, bags, lb	.19 –.....	.20 –.....	.20 –.....
Bleached, bonedry, bags, lb	.18 –.....	.19 –.....	.16½–.....
T. N. Bags, lb	.10 –.....	.10½–.....	.11 –.....
Soapstone (f.o.b. Vt.), bags, ton	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton	13.75 –.....	13.75 –.....	13.75 –.....

INDUSTRIAL NOTES

THE AMERICAN MAIZE-PRODUCTS CO., New York, has appointed Dr. A. P. Hellwig assistant bulk sales manager. Dr. Hellwig also will continue as manager of the technical service division.

DETROIT REX PRODUCTS CO., Detroit, has expanded its sheet metal manufacturing division. I. J. Belanger has been appointed manager.

HOWELL ELECTRIC MOTORS CO., Howell, Mich., has appointed Aubrey Flood as vice-president in charge of sales.

THE FLUOR CORP. LTD., Los Angeles, has acquired THE COOLING TOWER CO., New York. No immediate changes will be made in the distribution divisions of either company.

MANNING, MAXWELL & MOORE, Bridgeport, Conn., has appointed C. H. Butterfield vice-president and general sales manager of the industrial and railroad divisions.

LANCASTER IRON WORKS, INC., Lancaster, Pa., has consolidated its engineering, research, and development activities at its new laboratories at Hackensack, N. J., with E. B. Mallory in charge.

THE MERCOID CORP., Chicago, has announced that J. A. Johnson is now associated with that company in the office at 25 Ivy St., Boston.

CRUCIBLE STEEL CO. OF AMERICA, New York, has appointed W. E. Gardner to succeed W. P. Knecht as manager at Cambridge, Mass. Mr. Knecht is now manager of the London office.

C. M. KEMP MFG. CO., Baltimore, has appointed the W. C. GREEN CO., Cincinnati, as representative in that territory and BELTAIRE & DRISSEN, Detroit, as Michigan representative.

INDUSTRIAL INSTRUMENTS, INC., has been formed at Bayonne, N. J. with Nathan Schnoll as president and chief engineer. Sales promotion is in charge of Sylvan A. Wolin.

New CONSTRUCTION

PROPOSED WORK

Carbon Plant—Great Lakes Coal & Coke Co., 910 South Michigan Ave., Chicago, Ill., will soon award the contract for a carbon plant at Niagara Falls, N. Y. Estimated cost will exceed $40,000.

Distillery—Winnebago Distillery Co., c/o Paul Gerhardt, Archt., 447 West Fullerton Pkway., Chicago, Ill., will take bids on revised plans for the construction of a distillery at South Elgin, Ill. Estimated cost $800,000.

Glass Factory—Hobbs Glass Mfg. Co., Ltd., 894 St. James Ave., W., Montreal, Que., Can., has purchased a site at Three Rivers, Que., and plans to construct a factory. Estimated cost $50,000.

Laboratory—Department of Public Works, Ottawa, Ont., Can., is having plans prepared by C. D. Sutherland, Archt., Ottawa, for the construction of a new annex to the laboratories of the National Research Council on Sussex St., Ottawa. Estimated cost $1,459,895.

Laboratory—National Carbon Co., C. J. Koster, Works Engr., Fostoria, Ohio, plans to construct a 2 story, 60x120 ft. laboratory and office building. Estimated cost $60,000.

Paper Mill—Ontario Paper Co., Ltd., A. A. Schmon, Pres., Allenburg Rd., Thorold, Ont., Can., plans to construct an addition to its mill. L. C. Anderson, c/o Owner, Engr. Estimated cost $150,000.

Paper Mill—Regal Paper Co., Pulaski, N. Y., plans to construct a 2 story, 60x125 ft. addition to its mill. C. H. Fournier, East Mohawk St., Oswego, Archt.

Paper Box Factory—U. S. Fibre Box Co., H. J. Lacy, Sr., Pres., 1409 Roosevelt Ave., Indianapolis, Ind., plans to construct a 1 story factory. Estimated cost $40,000.

Pulp Mill—North Carolina Pulp Co., Plymouth, N. C., subsidiary of Kieckhefer Container Co., Delair, N. J., plans to construct a new unit at its plant at Plymouth, including homes for 150 employees. Estimated cost between $800,000 and $1,000,000.

Photographic Supplies Factory—Chilcote Co., A. A. Chilcote, Pres., 2140 Superior Ave., Cleveland, O., is having plans prepared by H. E. Shimmin, Archt., 1720 Euclid Ave., Cleveland, O., for the construction of a 1 story 50x150 ft. addition to its factory. Estimated cost $40,000.

Plant—Celanese Corp. of America, W. McC. Cameron, Executive Vice Pres., 180 Madison Ave., New York, N. Y. will soon award the contract for the first unit of a plant at Pearisburg, Va., to cost $750,000. Total estimated cost of project $10,000,000.

Soap Factory—Proctor & Gamble Co., Main and 6th Sts., Cincinnati, O., plans to construct a 6 story, 120x325 ft. soap manufacturing factory at Quincy, Mass. R. M. Rice, Archt. and H. Manley, Engr., both 655 Fifth Ave., New York, N. Y. Estimated cost between $750,000 and $1,000,000.

CONTRACTS AWARDED

Ammonia Plant—Hercules Powder Co., 225 Bush St., San Francisco, Calif., will construct an ammonia plant at Hercules, Calif. Work will be done by owner's forces. Estimated cost $200,000.

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1939	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$875,000	$45,000	$1,035,000	$195,000
Middle Atlantic	80,000	8,190,000	2,590,000	8,408,000
South	1,630,000	2,500,000	5,693,000	2,875,000
Middle West	940,000	620,000	1,350,000	370,000
West of Mississippi	.....	200,000	1,185,000	720,000
Far West	.....	240,000	80,000	826,000
Canada	1,660,000	2,000,000	4,910,000	2,115,000
Total	$5,205,000	$13,795,000	$16,843,000	$15,509,000

Asphalt Plant—Pennac Asphalt Products Co., E. W. Overdorff, Pres., Johnston, Pa., is building an asphalt plant on a 200x300 ft. site along the Conemaugh River. Project will include four 8,000 gal. steel storage tanks, one 5,000 gal. steel preheating tank, pump house, mixing tower, stone hopper, dryer and feeder bins and scale house. Work is being done by owner's forces. Separate bids will be asked for equipment. Estimated cost $40,000.

Carbon Black Gas Plant—General Atlas Carbon Co., Pampa, Tex., F. M. Perry, Engr., will construct a carbon black gas plant at Guymon, Okla. Work will probably be done by force account. Estimated cost $60,000.

China Factory—Crooksville China Co., Crooksville, O., has awarded the contract for the construction of a 1 story, 50x57 ft. factory to W. A. Showers Construction Co., Crooksville. Estimated cost $40,000.

Cotton Oil Mill—Chickasha Cotton Oil Co., Chickasha, Okla., has purchased a 20 acre site at Muleshoe, Tex., and will construct a cotton oil mill to have a capacity of 25,000 tons of cotton seed annually. Estimated cost $100,000. Work will be done by day labor and subcontracts.

Cyanide Mill—Caliente Cyaniding Co., Delamar, Nev., has awarded the contract for a 50 ton cyanide mill near Imlay, Nev., to Western Knapp Engr. Co., Balboa Bldg., San Francisco, Calif.

Laboratory — Machlett Laboratories, Inc., 1063 Hope St., Springdale, Conn., has awarded the contract for a 1 story, 79x127 ft. addition to W. J. Barney Co., 101 Park Ave., New York, N. Y. Estimated cost $45,000.

Lacquer Factory—E. J. Coyle & Co., 12 North Union Sta., Chicago, Ill., has awarded the contract for a 1 story, 75x135 ft. factory at Paulina St. and Carroll Ave., Chicago, to Campbell-Lowrie-Lautermilch Corp., 400 West Madison St., Chicago. Building will be leased to Maas & Waldstein Co., 438 Riverside Ave., Newark, N. Y., manufacturers of industrial lacquers. Estimated cost $40,000.

Gasoline Refinery—Consumers Cooperative Refineries, Ltd., Regina, Sask., Can., will construct a gasoline refinery by day labor under supervision of O. B. Males, Engr. Estimated cost $150,000.

Oil Refinery—Imperial Oil Ltd., Sarnia, Ont., Can., plans to start work on the construction of a new refinery and cracking plant at Calgary, Alta. The Company is interested in prices of complete equipment. Estimated cost $1,750,000.

Plastics Factory — Universal Plastics Corp., 235 Jersey Ave., New Brunswick, N. J., has awarded the contract for the construction of a 1 story, 50x120 ft. addition to W. Connolly, 14 Handy St., New Brunswick.

Oil Storage Tank—Allied Oil Co., Inc., Standard Bldg., Cleveland, O., has taken out a permit for the construction of an oil storage tank on the East Side of Toledo, Ohio. Estimated cost $500,000.

Paper Box Factory—Gibraltar Corrugated Paper Co., Inc., 1723 Bergen Turnpike, North Bergen, N. J., has awarded the contract for a 1 story, 76x300 ft. addition to its paper box factory to J. W. Ferguson Co., 152 Market St., Paterson, N. J.

Plant—E. I. duPont de Nemours & Co., Du Pont Bldg., Wilmington, Del., is building a plant at Belle, W. Va. Estimated cost $2,000,000.

Nylon Thread Plant—E. I. du Pont de Nemours & Co., Du Pont Bldg., Wilmington, Del., is building a plant at Seaford, Del., for the manufacture of Nylon thread. Estimated cost $8,000,000.

Pottery Plant—Crane Porcelain & Pottery Mfg. Co., Somerset, Tex., will construct a 2 story, 100x150 ft. pottery plant by day labor. M. Rice, 516 West Laurel St., San Antonio, Tex., Archt.

Salt Factory—Dominion Tar & Chemical Co., Ltd., L. O. P. Walsh, Pres., 606 Cathcart St., Montreal, Que., Can., will construct an addition to its salt plant at Waterways, Alta., using day labor. Estimated cost $100,000.

Soap Factory—Lever Bros. Co., Cambridge, Mass., has awarded the contract for a 2 story, 76x126 ft. and 4 story, 51x75 ft. addition to its factory at 5300 Holabird Ave., Baltimore, Md., to Stone & Webster, Inc., 49 Federal St., Boston, Mass. Estimated cost $110,000.

Tobacco Factory—United States Tobacco Co., 4325 West 5th St., Chicago, Ill., has awarded the contract for a 6 story, 100-350 ft. factory on Petersburg Pike, Richmond, Va., to John Felmley, Bloomington, Ill. Estimated cost $500,000.

MANUFACTURING INDUSTRIES TOOK SMALLER AMOUNTS OF OILS AND FATS LAST YEAR

INDUSTRIAL consumption of vegetable oils, animal fats, and related products showed a reversal in trend last year and fell below the 1937 volume by slightly more than 7.2 per cent. Soap makers made a relatively good showing with 1938 operations almost on a par with those for the preceding year. If allowance is made for losses, physical and refining, and for foots the edible trades account for approximately one-half of all the oils and fats which are processed. Last year the decline in consumption in the manufacture of edible products was about the same as the drop in total factory consumption.

A reduction of 21.9 per cent is reported for the amount of oils consumed last year in the manufacture of paint and varnish. Sales of paint and varnish by 680 establishments last year as given in the monthly releases of the Bureau of the Census were only 13.5 per cent below the 1937 totals so that a considerable drop in inventories is indicated for the year.

Producers of linoleum and oilcloth and of printing inks cut down their oil and fat requirements last year to about the same degree, both these industries having registered a decline of approximately 17 per cent.

While the falling off in factory consumption of oils was fairly general there were a few exceptions which showed up prominently in the case of coconut and soybean oils and edible and inedible tallow. Coconut oil not only was used in a larger way for the manufacture of edible products but also recorded a 36 per cent gain in soap-making use which offers an illustration of the interchangeability of raw materials in that industry. Inedible tallow owed its greater popularity last year to enlarged buying for soap-kettle account which in turn is not indicative of a trend but rather of a change in the relative price position of the different soap-making raw materials.

Soybean oil, which has been attaining greater importance in late years, is consumed largely as a refined product and its larger sale last year resulted from a wider outlet in edible products with only the linoleum and oilcloth trade accounting for any material improvement in demand for the crude product. Total soybean factory consumption for 1938 was reported at 243,613 thousand pounds which is an increase of 65,097 thousand pounds over the 1937 figure. Consumption in edible products was 194,483 thousand pounds or 56,362 thousand pounds more than in 1937.

In the quarterly reports of the Bureau of the Census, the domestic output of linseed oil for 1938 was placed at 440,614,136 lb., stocks declined from Jan. 1 to Dec. 31 by 40,600,836 lb., thus indicating a total consumption of more than 490 million pounds. Deducting the factory consumption, approximately 190 million pounds would be available for direct use in the form of oil compared with 216 million pounds in the preceding year.

The effect of unsettled conditions in primary markets undoubtedly had an effect on domestic consumption of China wood oil. It is true that there was no scarcity of supplies because stocks at the close of 1938 were nearly 13 million pounds larger than at the beginning of the year. Yet in the two largest outlets—manufacture of paint and varnish and linoleum and oilcloth—consumption last year fell off more than 30 per cent and 40 per cent respectively while consumption of linseed oil dropped less than 19 per cent in the same industries.

The following tables show the relative importance of the different industrial consuming outlets for oils and fats, the annual consumption by industries for the last seven years, and for 1938, detailed statistics for consumption by classes of products.

Industry consumption of fats and oils in 1938

	Per cent of total
Shortening	32.6
Oleomargarine	6.7
Other edible products	8.1
Soap	31.7
Paint and varnish	7.7
Linoleum and oilcloth	1.9
Printing inks	0.5
Miscellaneous products	5.7
Loss including foots	5.1
	100.0

Factory Consumption of Oils and Fats by Industries

(Thousands of pounds)

	Edible Use	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Ink	Total*
1938	2,200,290	1,468,535	357,625	85,362	21,884	4,634,135
1937	2,372,430	1,475,756	457,785	102,763	26,213	4,993,914
1936	2,296,646	1,394,538	441,282	101,882	20,206	4,784,226
1935	2,172,757	1,312,690	404,705	81,031	18,000	4,494,287
1934	1,721,340	1,474,415	329,894	67,811	15,544	4,028,003
1933	1,418,689	1,311,263	297,560	69,938	13,419	3,514,641
1932	1,325,340	1,375,416	254,251	57,515	10,431	3,355,555

* Includes miscellaneous uses and losses.

Factory Consumption of Primary Animal and Vegetable Fats and Oils, by Classes of Products, Calendar Year 1938
(Quantities in thousands of pounds)

KIND	TOTAL	Shortening	Oleomargarine	Other Edible Products	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Inks	Miscellaneous Products	Loss Including Foots
Total	4,634,135	1,512,299	310,936	377,055	1,468,535	357,625	85,362	21,884	264,877	235,562
Cottonseed oil	1,528,805	1,040,162	142,857	198,155	2,883	184	.....	168	2,971	141,425
Peanut oil	62,461	52,402	3,593	1,920	545	.....	.....	.....	32	3,969
Coconut oil	555,017	26,199	89,521	61,493	342,982	422	.....	2	3,572	30,826
Corn oil	72,770	399	566	57,104	2,514	118	.....	.....	3,345	8,724
Soybean oil	243,613	143,318	39,885	11,280	10,897	15,183	3,605	59	5,340	14,046
Olive oil, edible	2,990	.....	.....	2,850	31	.....	.....	.....	109	.....
Olive oil, inedible	4,248	.....	.....	.....	1,299	6	.....	.....	2,943	.....
Sulphur oil or olive foots	15,378	.....	.....	.....	15,013	.....	.....	.....	365	.....
Palm-kernel oil	51,962	614	4,746	13,118	29,498	.....	.....	.....	40	3,946
Palm oil	253,150	115,033	.....	444	91,642	1	.....	9	19,905	26,116
Babassu oil	32,468	950	11,545	8,969	8,289	.....	.....	.....	.....	2,715
Sesame oil	7,568	5,435	.....	1,573	302	.....	.....	.....	24	234
Rapeseed oil	5,317	297	.....	.....	55	131	2	1	4,831	.....
Linseed oil	298,481	6	.....	.....	1,455	216,568	55,395	16,804	8,253	.....
Tung oil	87,415	.....	.....	.....	.....	78,310	4,131	2,084	2,890	.....
Perilla oil	32,649	.....	.....	.....	.....	23,528	6,952	1,762	407	.....
Castor oil	28,160	.....	.....	.....	1,810	5,283	1,313	200	19,554	.....
Other vegetable oils	31,952	695	70	6,525	14,031	1,912	115	106	7,304	1,194
Lard	9,925	2,825	1,464	5,518	1	.....	.....	2	20	95
Edible animal stearin	41,616	32,845	3,278	5,074	240	.....	.....	.....	144	35
Oleo oil	14,235	291	13,411	40	119	2	.....	.....	323	49
Tallow, edible	78,320	74,251	.....	2,992	332	.....	.....	2	557	186
Tallow, inedible	764,041	.....	.....	.....	702,267	117	.....	4	61,437	216
Grease	182,767	.....	.....	.....	96,356	144	1	420	85,083	763
Neat's-foot oil	4,757	.....	.....	.....	20	9	.....	2	4,726	.....
Marine animal oils	70,664	48	.....	.....	66,080	28	.....	5	4,467	36
Fish oils	153,406	16,529	.....	....	79,874	15,679	13,848	254	26,235	987